Importance

This manual provides information needed to service the Aeon7500A anesthetic machine. This manual is intended for use by certified biomedical engineering technicians or personnel with equivalent experience and training in servicing this type of equipment. It is recommended that the user complete the Aeonmed training class geared specifically to the Aeon7500A anesthetic machine.

While this manual covers the anesthetic machine configurations currently supported by Aeonmed, it may not be all-inclusive and may not be applicable to your anesthetic machine. Contact Aeonmed for questions regarding the applicability of the information.

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1 Introduction

1.1 What the manual's symbols mean?

⚠ Warnings and ⚠ Cautions indicate all the possible dangers in case of violation of the stipulations in this manual. Refer to and follow them.

⚠ **WARNING**: indicates potential hazards to operators or patients

⚠ **CAUTION**: indicates potential damage to equipment

Instead of illustrations, other symbols may also be utilized. Not all of them may necessarily appear in the equipment and manual. The symbols include:

I	ON（Power）		Type B equipment
O	OFF（Power）	⚠	Warning or Caution, ISO 7000-0434
~	Alternating Current	⚠⚠	NOTE: refer to the manual, IEC601-1
⏚	Protectively earth	ϟ	Dangerous Voltage
⏚	Equipotential	SN	Serial Number
⊕	Input		Date of manufacture
⊖	Output		Address of manufacture
Inspiration	Inspiration flow	Expiration	Expiration flow

Alarm Silence

View the reading on the top of float

Ventilator operate / Auto ventilation

Bag operate / Manual ventilation

Movement in one direction

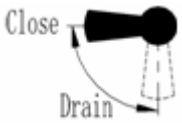
Movement in two directions

Lock

Unlock

Oxygen flush

CE Representative



Directions of Drain Valve

The system, with this label under the stipulations in the operating manual, complies with the requirements related from 93/42/EEC. xxxx is the certificate number used by Aeonmed quality system to certify authorizations

1.2 Definitions, Acronyms, and Abbreviations

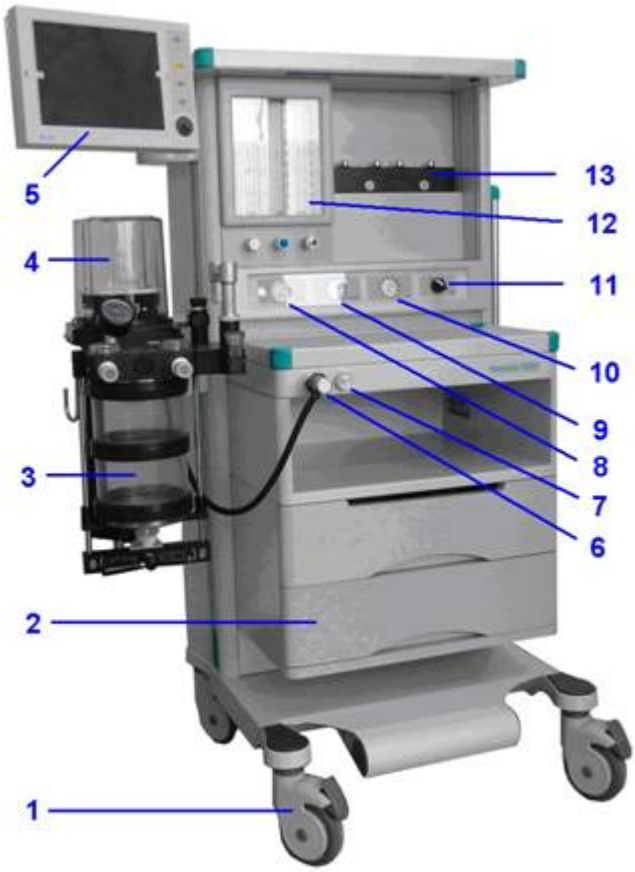
f	Respiratory rate, i.e. breaths per minute (setting)
f_{spont}	Respiratory rate of spontaneous breathing by the patient (monitored)
f_{total}	Total respiratory rate, i.e. sum of f and f_{spont} (monitored)
FiO_2	Delivered oxygen percentage (monitored data)
FiO_2	Oxygen percentage (setting)
I : E	Inspiration to expiration time, I to E ratio, (monitored)
MV	Exhaled minute volume (monitored)
MV_{spont}	Minute volume of spontaneous expiration by the patient (monitored)
Paw	Patient airway pressure
PEEP	Positive end expiratory pressure (monitored data)
P_{limit}	Inspiratory airway pressure in PCV (setting)
P_{mean}	Mean airway pressure is updated every at the end of last breath cycle, i.e. a running mean (monitored)
P_{peak}	Maximum patient airway pressure during a patient breath (monitored)
P_{plat}	Patient airway pressure measured at the end of inspiratory pause time (monitored)
V_{sens}	Volume sensitivity (setting)
T_P	Inspiratory pause time; increase inspiration time to facilitate increased patient oxygenation (setting)
V_T	Tidal volume of mechanically delivered breaths (setting)
V_{TE}	Exhaled tidal volume (monitored)
V_{TI}	Inhaled tidal volume (monitored)

1.3 Tools and equipments (for servicing and testing)

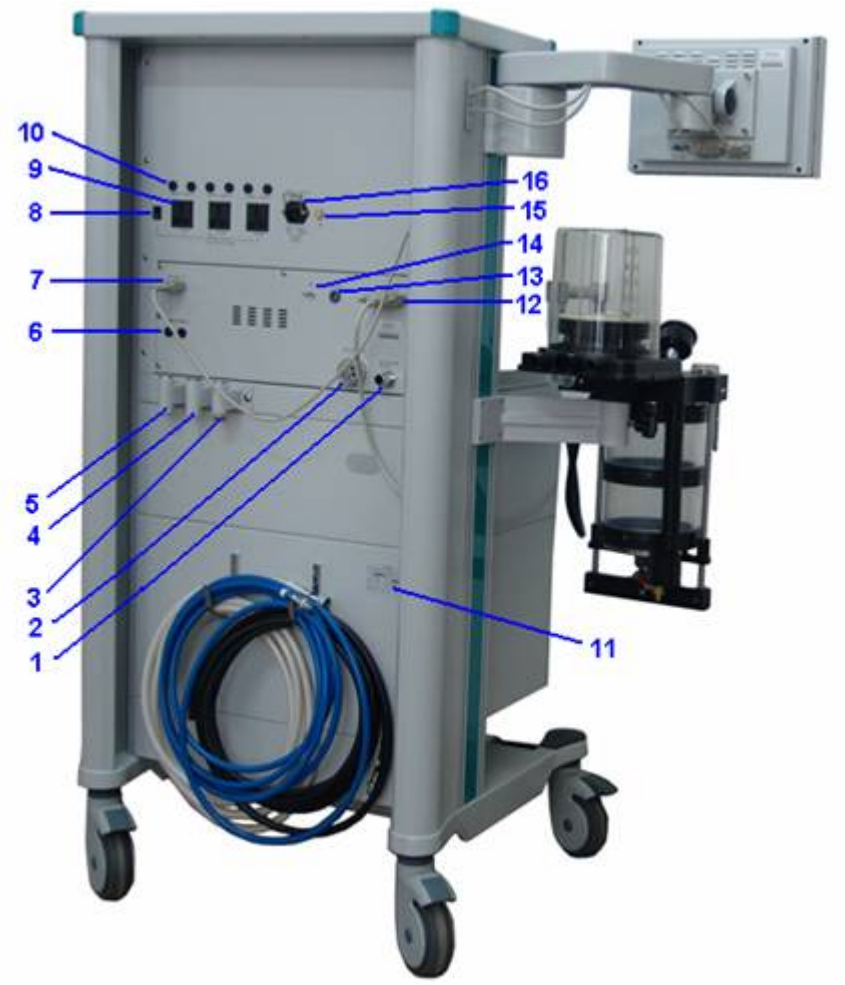
Task	Equipment
Routine verification	Aeon7500A User Manual
Ventilation mode checkout	Respirometer (hand-held)
	Stop Watch
Changing fuses	Small slotted screwdriver
	Fuses
Power switchover test	External battery and cable
Cleaning	Mild detergent
Disassembly	One set of Allen keys Cross-screwdriver Wrench

2 Structure and Operation principle

2.1 System components



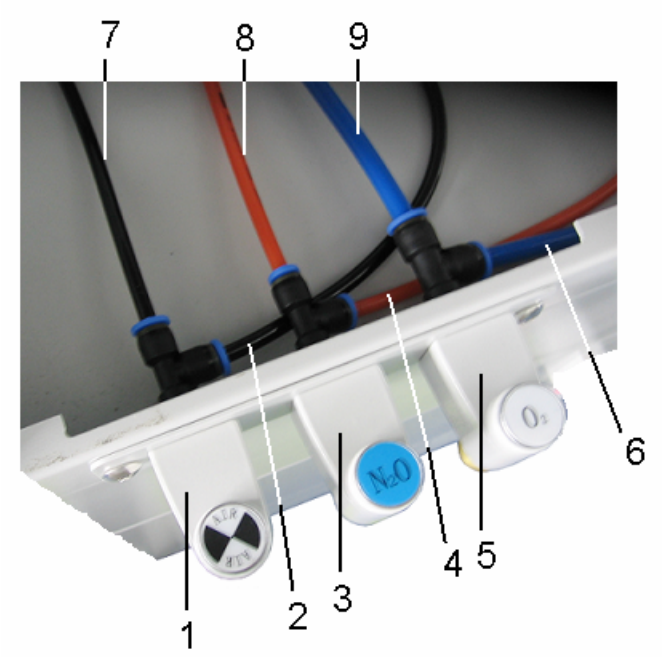
1	Castor	2	Drawer
3	Absorber circuit	4	Bellows assembly
5	MV300 Screen	6	Common gas outlet
7	O_2 flush	8	O_2 pressure gauge
9	N_2O pressure gauge	10	Air pressure gauge
11	Power switch	12	Flowmeter
13	Manifold valve		



1	Inhalation port	2	Exhalation port
3	O_2 inlet	4	N_2O inlet
5	Air inlet	6	Fuse
7	Analogue port	8	Auxiliary mains socket outlet switch
9	Auxiliary mains socket outlet	10	Fuse
11	Nameplate	12	Cable port
13	O_2 sensor interface	14	P&V interface
15	Equipotential	16	Power socket

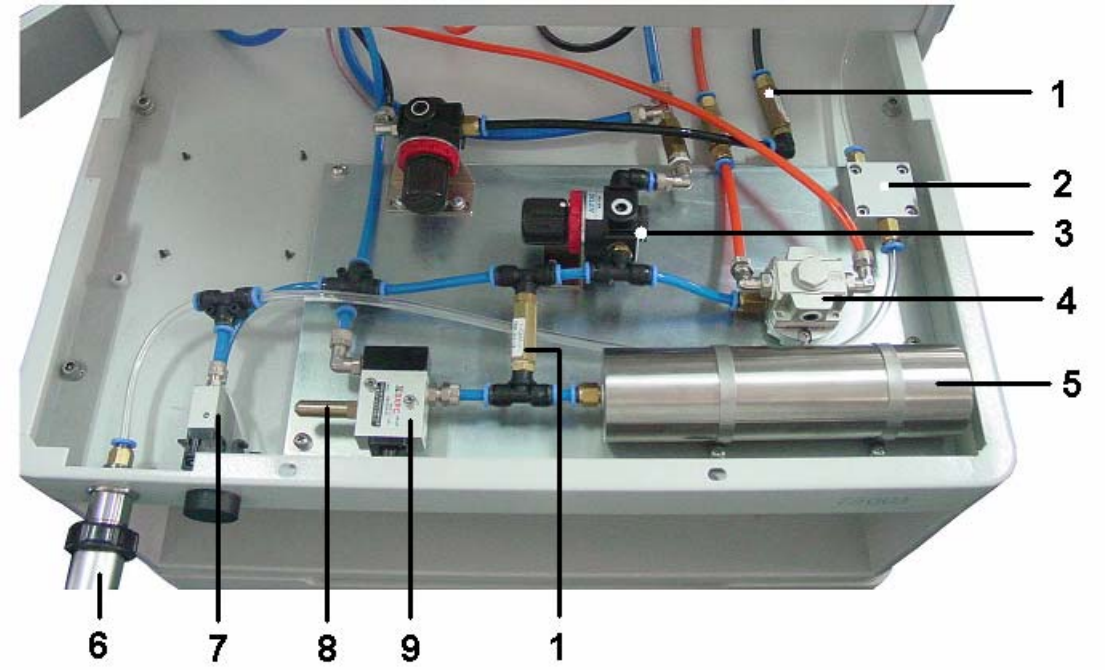
2.2 Pneumatic system

2.2.1 Gas supply



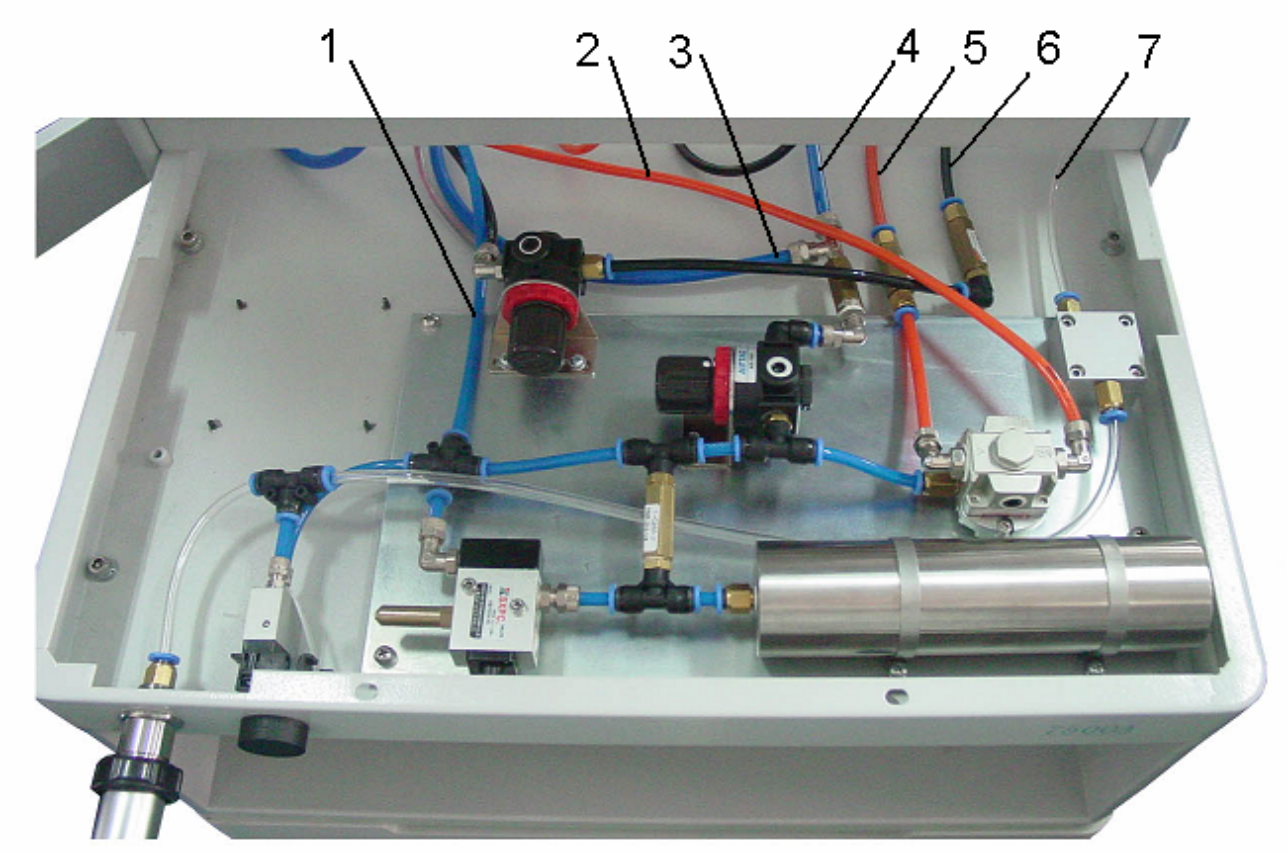
1	Air inlet	2	Connect to Air Pressure gauge	3	N_2O inlet
4	Connect to N_2O Pressure gauge	5	O_2 inlet	6	Connect to O_2 pressure gauge
7	Air pipe	8	N_2O pipe	9	O_2 pipe

2.2.2 Gas board

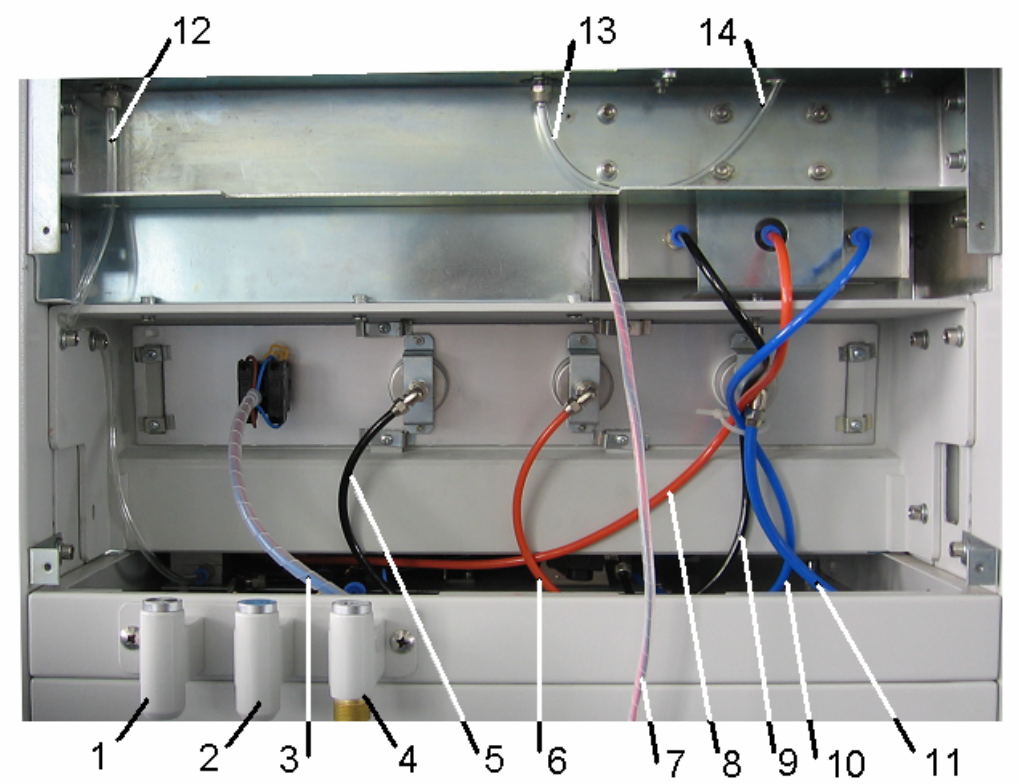


1	Checkvalve	2	Micro-checkvalve	3	reducer
4	N2O cut-off valve	5	Gas reservoir	6	Common gas outlet
7	O2 flush valve	8	Whistle	9	Reversal valve

2.2.3 Pipe connection

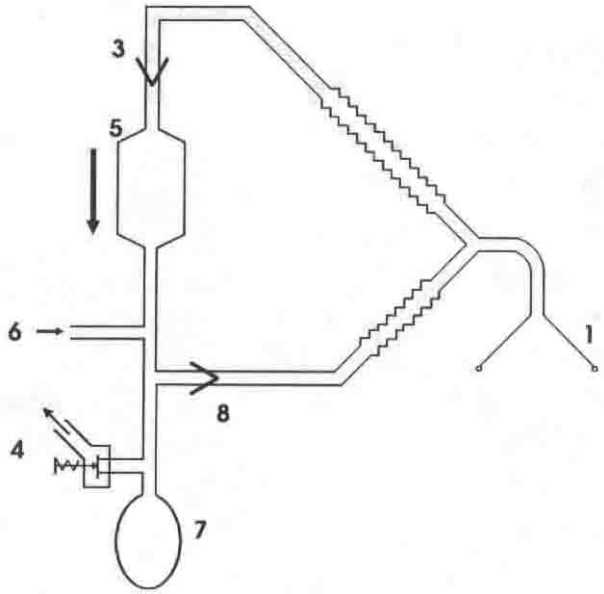


1	Connect to O_2 flowmeter	2	Connect to N_2O flowmeter	3	Connect to MV300 gas box
4	Connect O_2 inlet	5	Connect to N_2O inlet	6	Connect to Air inlet
7	Connect to vaporizer				



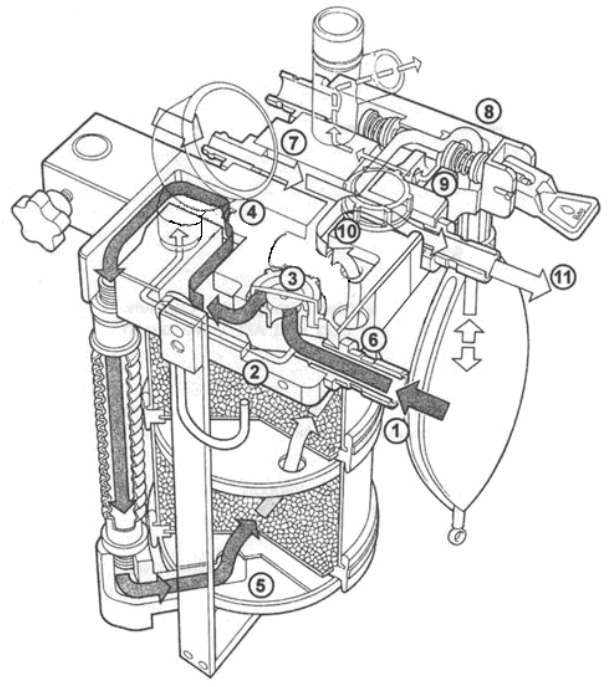
1	Air inlet	2	N_2O inlet	3	Connect to power supply
4	O_2 inlet	5	Connect to Air pressure gauge	6	Connect to N_2O pressure gauge
7	Connect to power board	8	Connect to N_2O flowmeter	9	Connect to Air flowmeter
10	Connect to O_2 flowmeter	11	Connect to O_2 pressure gauge	12	Connect to vaporizer outlet
13	Connect to vaporizer inlet	14	Connect to flowmeter outlet		

2.2.4 Absorber circuit



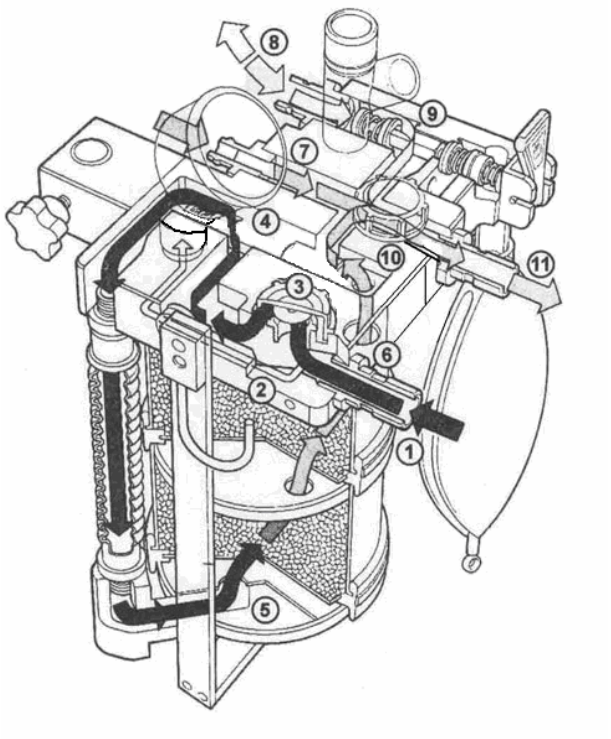
1 patient	2 inhalation valve	3 exhalation valve	4 APL valve
5 absorber	6 fresh gas compensation	7 manual reservior	

1. Manual ventilation gas flow diagram



1	Exhalant gas from patient	2	Pressure sampling for exhalant gas
3	Pass exhalation valve (non-return)	4	Airway pressure gauge
5	Exhalant gas enter absorber	6	Non-absorbed gas leave absorber
7	Fresh gas compensation	8	Manual / Auto ventilation switch
9	Pressure sampling path for APL valve	10	Inhalation valve (non-return)
11	Inhalant gas to patient		

2. Auto ventilation gas flow diagram



1	Exhalant gas from patient	2	Pressure sampling for exhalant gas
3	Pass exhalation valve (non-return)	4	Airway pressure gauge
5	Exhalant gas enter absorber	6	Non-absorbed gas leave absorber
7	Fresh gas compensation	8	Flow from ventilator
9	Manual / Auto ventilation switch	10	Inhalation valve (non-return)
11	Inhalant gas to patient		

2.2.5 Bellows assembly

Ports

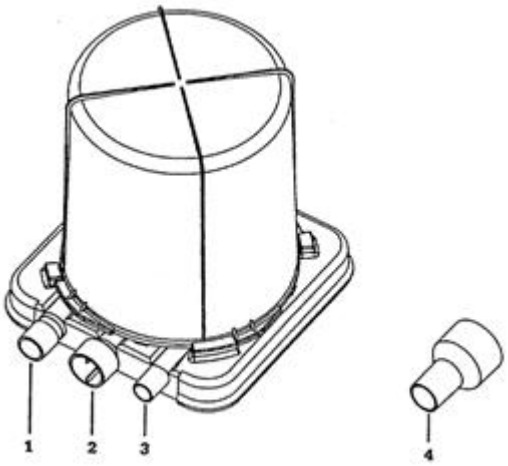


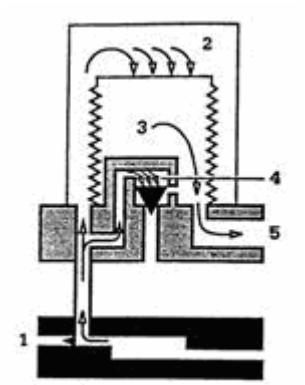
Figure 2-1 Ports of bellows assembly

1 Breathing system connector 2 Exhaust gas port 3 Driven gas connector 4 Adapter

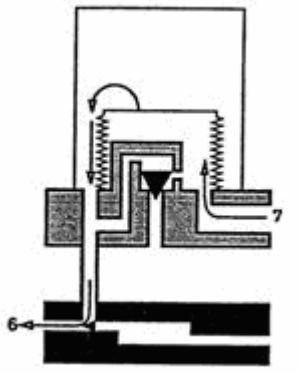
⚠ **WARNING: Never connect exhaust gas port with sub-atmospheric system directly. Or else leakage of breathing system generates.**

The adapter can be used to connect the waste gas scavenging system to the bellows assembly if the standard pipeline is used in the waste gas scavenging system.

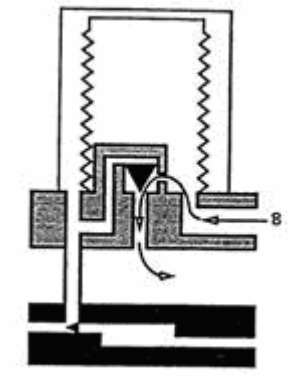
Ventilating circulation



Inhalation primary phase:
1 Exhalation valve
2 Driving gas
3 Gas of patient circuit
4 Spill-over valve
5 To patient circuit



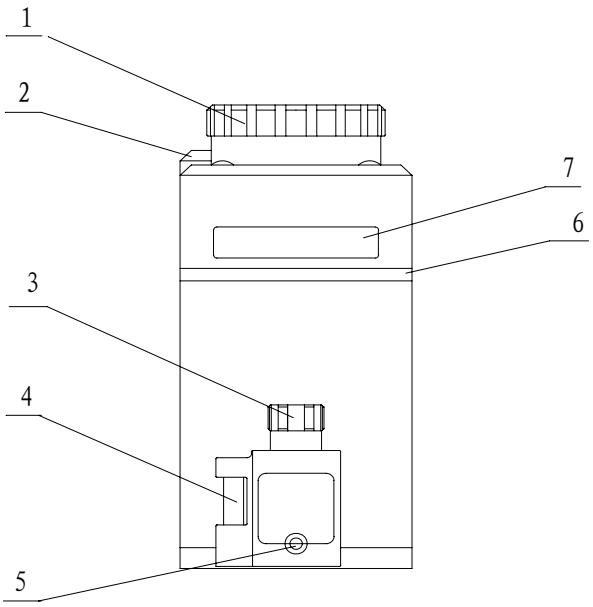
Exhalation primary phase:
6 Driving gas
7 From patient circuit



Exhalation end phase:
8 Excess gas of patient circuit

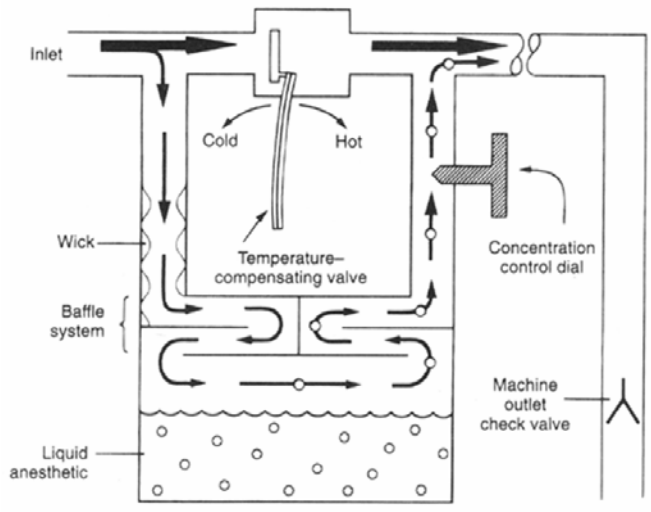
2.2.6 Vaporizer

Structure



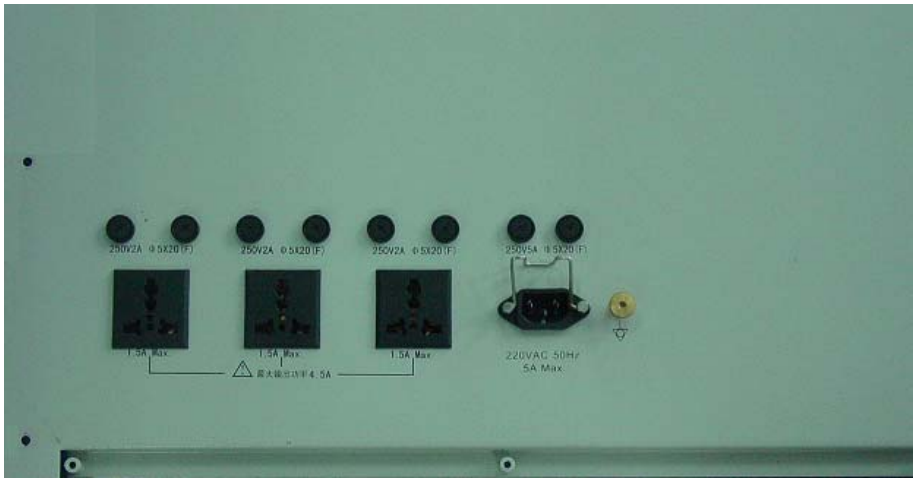
1	control dial	2	'OFF' lock position	3	filling cap	4	liquid level indicator
5	drain valve	6	color coding	7	label		

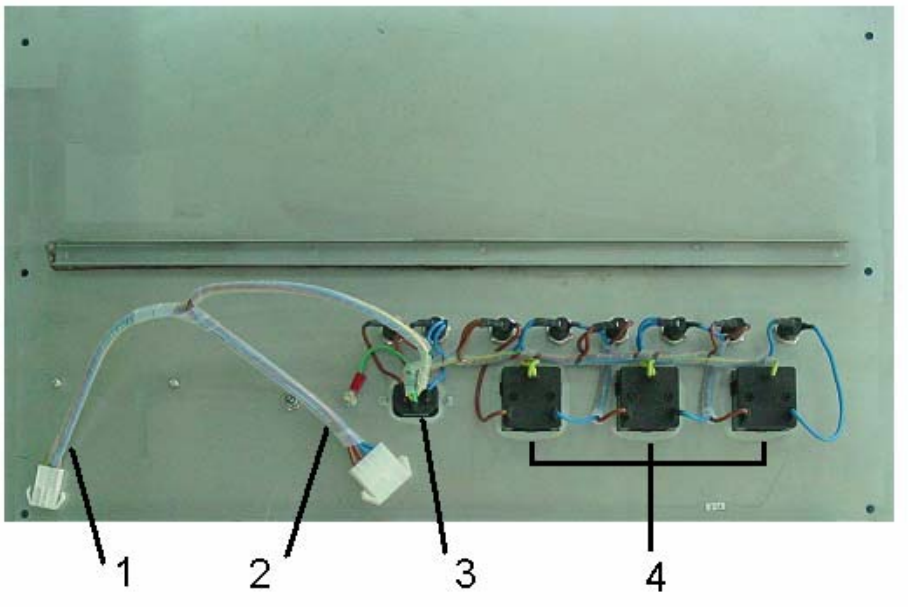
Operational principle



2.3 Electrical system

2.3.1 Power supply





1 connect with anesthetic ventilator 2 connect with power switch
3 Power socket 4 Auxiliary mains socket outlet

2.3.2 MV300 anesthetic ventilator

2.3.2.1 Operation principle

The high-pressure oxygen enters the pressure reduction valve I, and the output pressure from the pressure reduction valve I is stabilized at 0.25MPa (already adjusted before ex-factory). The output gas from the pressure reduction valve I enters the electromagnetic valve. In inspiring, the electromagnetic valve is open; the two-way outputs enter the flow valve and the pressure reduction valve II respectively. The one entering the pressure reduction valve II presses on the diaphragm in the expiration valve by means of the gas pressure to control the opening and closing of the expiration valve, and the output pressure is stabilized at 0.05MPa (already adjusted before ex-factory). The other one enters the flow valve; the tidal volume value could be changed through adjusting the flow valve. The pure oxygen entering the gas line is mixed in accordance with a certain proportion in the gas room. The air enters from the venturi-type valve, and a unidirectional valve is installed in the venturi-type valve to prevent the gas overflowing.

The sponge gas entrance is adopted for the unidirectional valve to reduce noise and filtrate the gas to be breathed in. A safety valve is installed on the side face of the gas room to prevent that the air pressure is too high and will make hurt to a patient. When the air pressure exceeds the set value of the safety valve (6kPa), the safety valve can open automatically and the gas will be discharged from the safety valve. The electromagnetic valve will be closed in expiration, the pressure exerted on the diaphragm of the expiration valve will disappear, and the diaphragm will loose. Thus the gas room connects with the atmosphere directly. The gas compressed in the bellows by the ventilator will discharge to the atmosphere through the expiration valve. The process above will be repeated along with the breath rhythm.

During the above procedures, it is the electromagnetic valve that controls the gas flowing direction, and is controlled by the mainframe board. In inspiration the electromagnetic valve will be opened while in expiration it will be closed. In the Figure 2-2, the display plate is used for the digital display for the respiration rate, breath frequency, the tidal volume and the oxygen concentration, the display of the corresponding display lamps and the display of the luminous line of the pressure. The mainframe board is the central processing unit of the ventilator circuit part. It not only controls the opening and closing of the electromagnetic valve, but also receives and processes the pressure signal, the flow signal. It receives the inputs from the panel and sends the signal that will be outputted to display to the display plate. The voltage stabilizing power supply provides the circuit needed voltages. The functions of the subsystems above are set and adjusted by the keys on the panel.

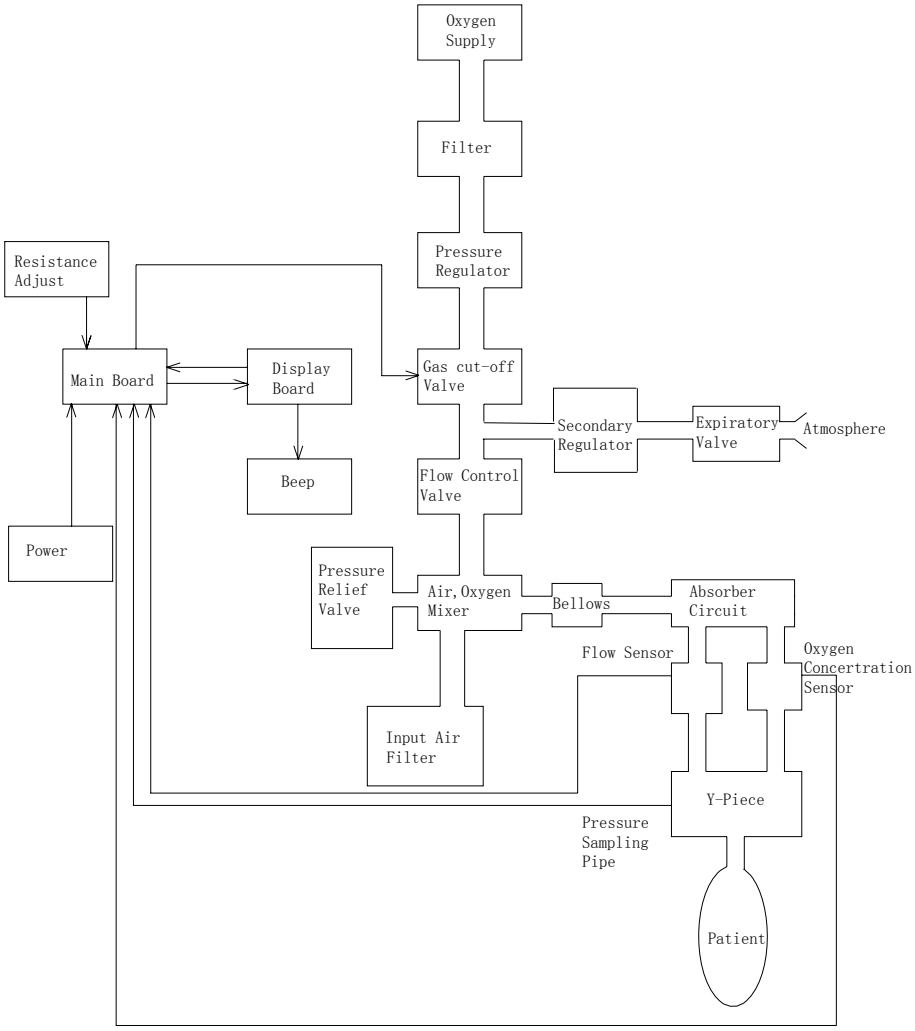


Figure 2-2 Operation principle sketch diagram of ventilator

2.3.2.2 MV300 components

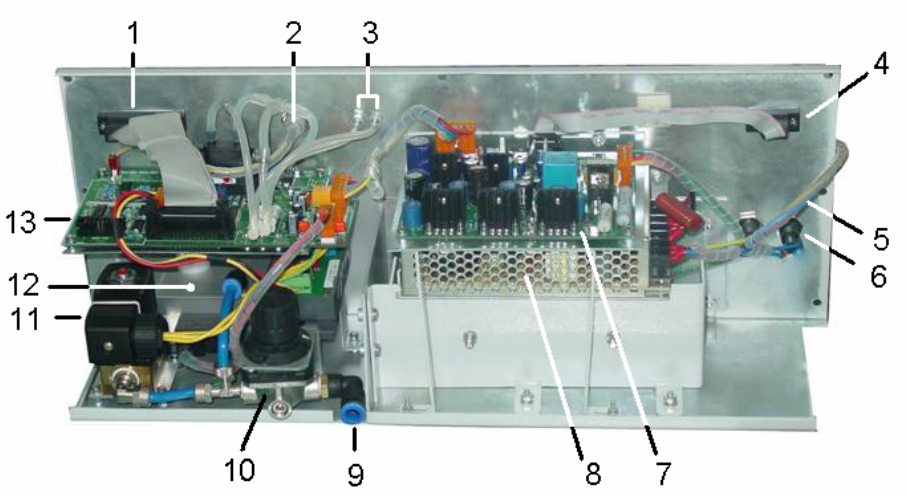


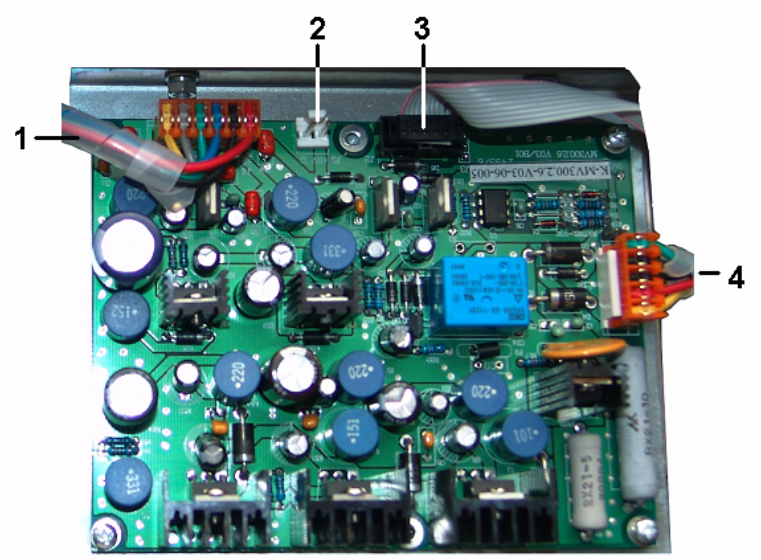
Figure 2-3 MV300 components

Figure 2-4 MV300 backview

1	Cable interface	2	O2 sensor interface	3	P&V interface
4	Analogue interface	5	Connect with power supply	6	Fuse
7	Power board	8	Switch power supply	9	O2 inlet
10	Reducer	11	Flow valve	12	Exhalation valve
13	Sensor board				

2.3.2.3 Power board

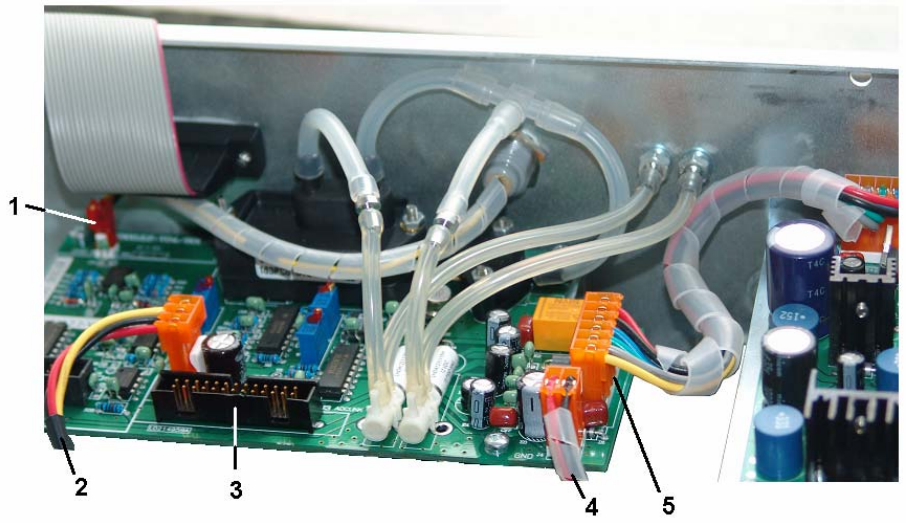
Function: Providing miscellaneous power supply for internal circuit, such as logic power supply, drive power supply for valve body, analogue power supply for amplifier circuit etc.



1 connect with sensor board 2 connect with top light
3 connect analogue interface 4 connect switch power supply

2.3.2.4 Sensor board

Function: Amplify system-control signal and drive executive element.



1 connect O2 sensor 2 connect flow valve 3 connect cable interface
4 connect exhalation valve 5 connect power baord

2.3.2.5 Exhalation valve

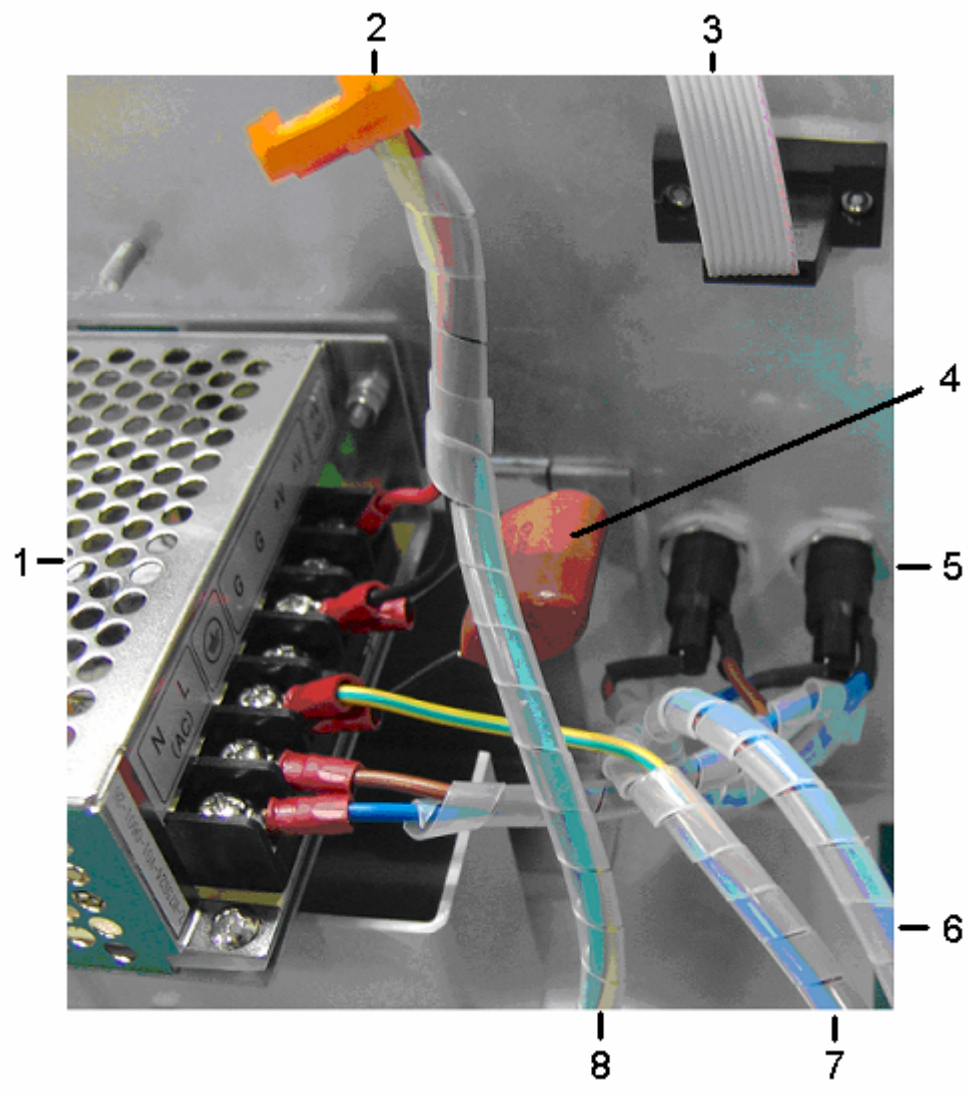
It’s made up of gasket, spring and block seat as shown in the following figure.
Caution: Block seat can move freely after fixing.

2.3.2.6 Flow valve and reducer

Flow valve control-board: Drive circuit for flow valve.

2.3.2.7 Switch power supply

Function：Change AC to DC for providing power required.



1	Switch power supply	2	Connect power board	3	Analogue harness
4	capacitance（0.47uf/1600V）	5	Fuse 250V 1A φ5×20（T）	6	Connect absorber heater（optional）
7	Connect power supply	8	Connect battery		

2.3.3 MV300 screen

Figure 2-5 MV300 screen frontview

On the back panel of MV300 screen, there are three interfaces: CRT interface, Cable interface and Analogue interface.

CRT interface: used to connect external display.

Cable & Analogue interfaces: provide power supply and signal to the display.

Figure 2-6 MV300 screen rearview

2.3.3.1 MV300 screen internal structure

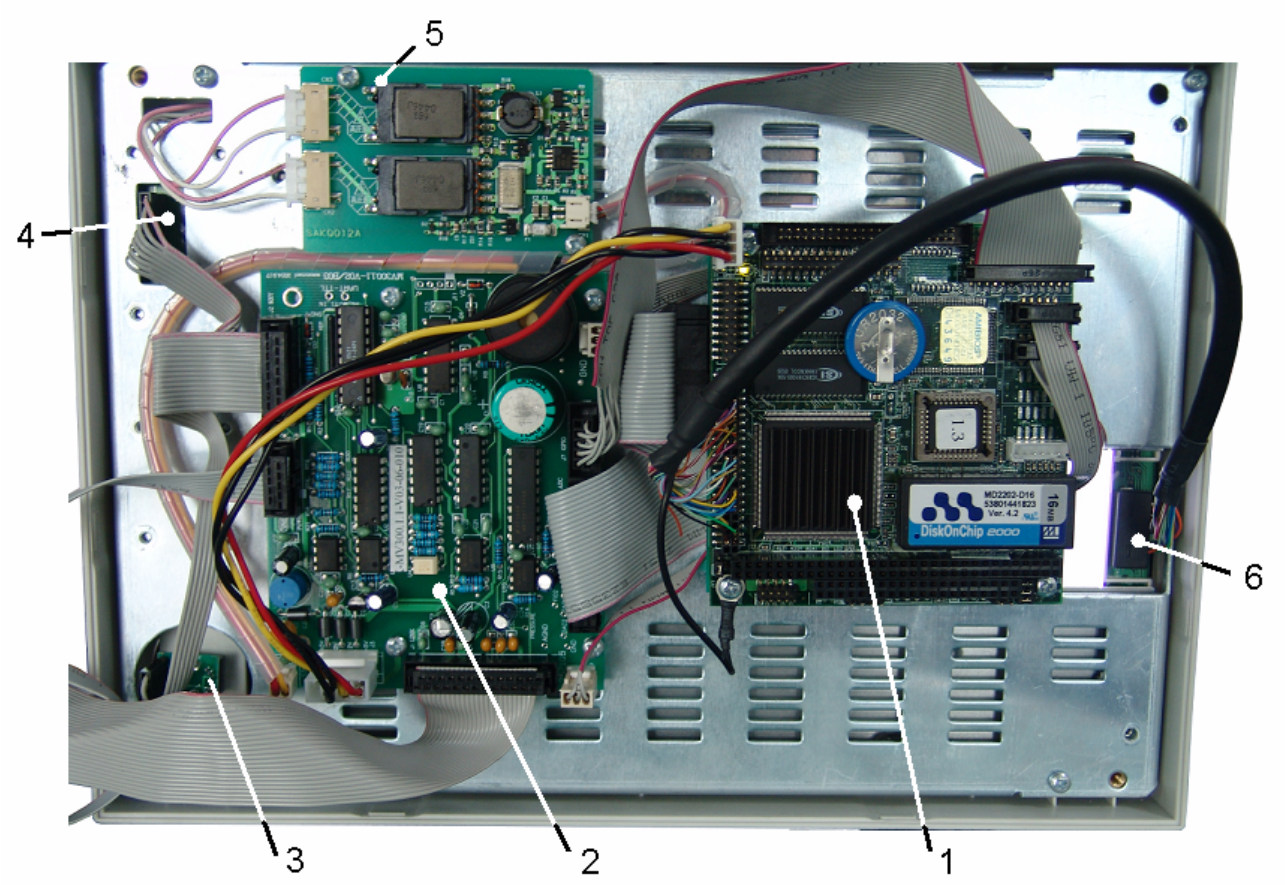
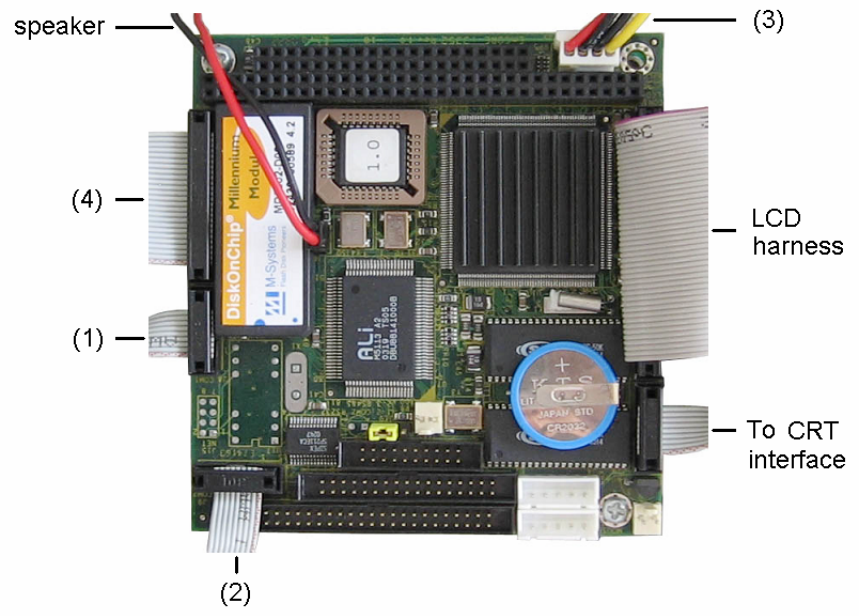


Figure 2-7 MV300 screen internal structure

1	PC104 mainboard	2	Communication board	3	Knob PCB
4	Keyboard PCB	5	Inverter PCB	6	LCD harness

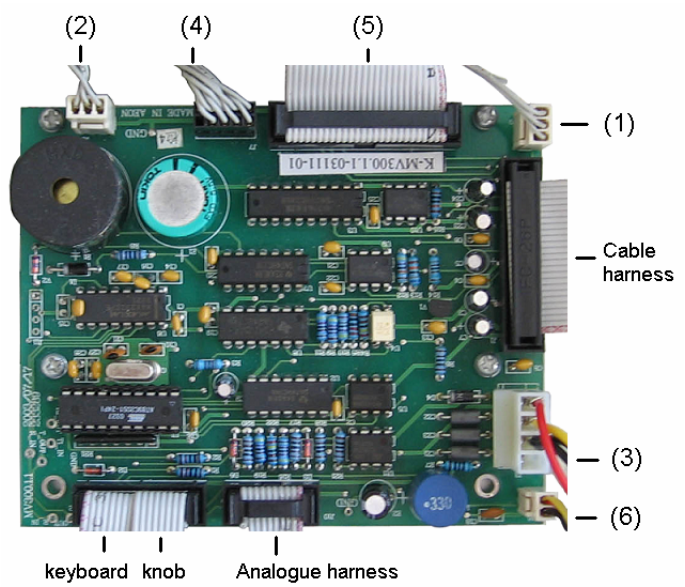
2.3.3.2 PC104 mainboard

PC104 mainboard is the core controller of system. It's intended for signal processing, signal control, equipments management and information display etc.
Warning: Wrong connection may lead to mainboard burned.



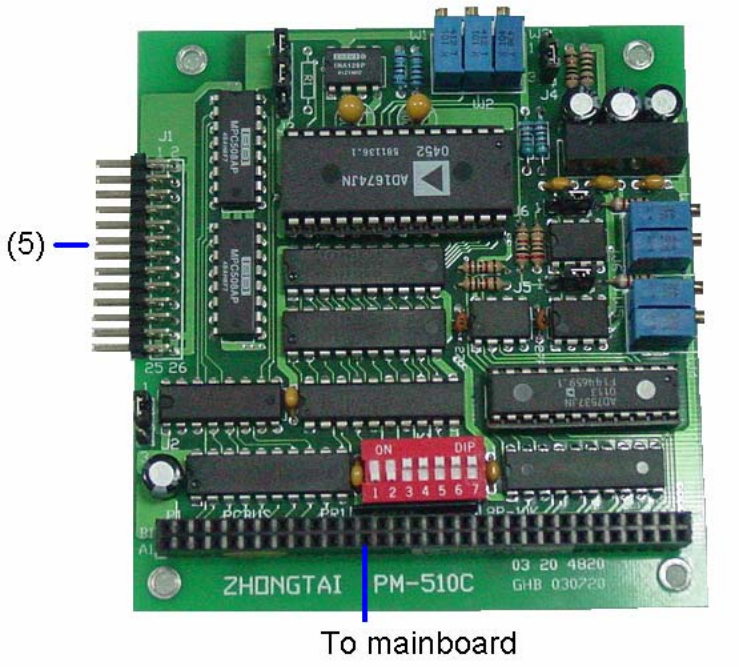
2.3.3.3 Communication board

Communication board: A sort of extended control unit, connected with mainboard by serial interface. It' used for signal connection, keyboard input and power management and so on.



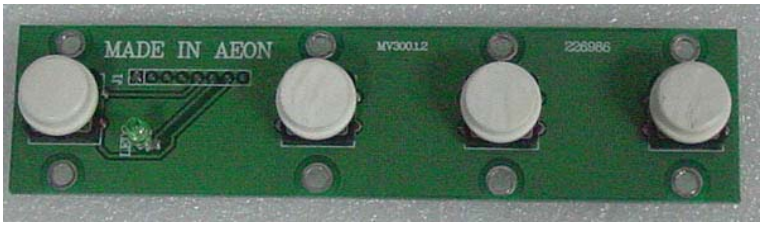
2.3.3.4 PM510 collecting board

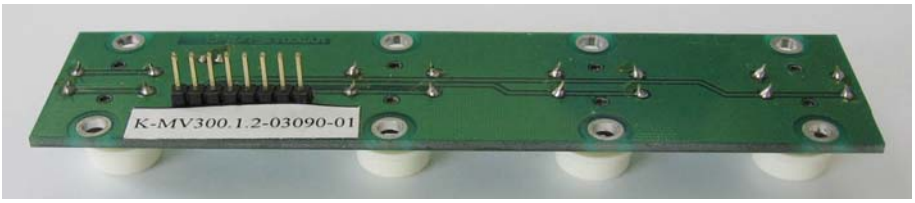
Function: signal acquisition for 104 buses.



2.3.3.5 Keyboard PCB

There are four keys and one power indicator on the face of keyboard PCB. And, one 8-pin male stitch on the back used to connect with communication board.





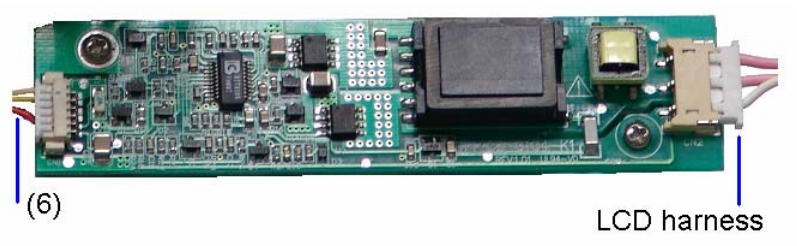
2.3.3.6 Inverter

Function: Providing high voltage for display startup required.

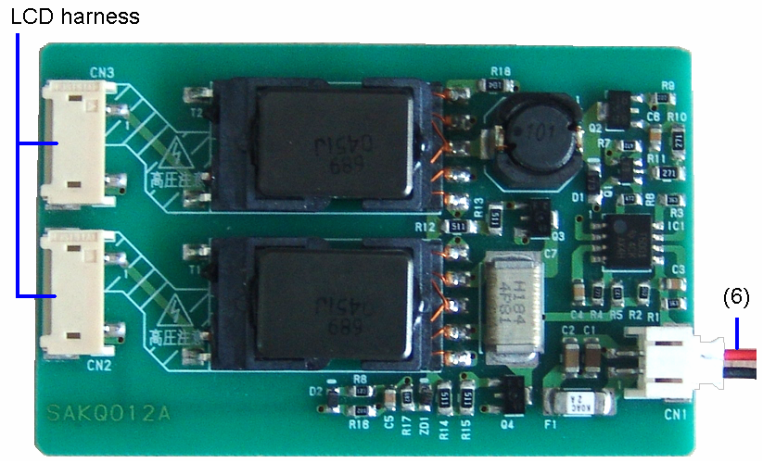
WARNING: No touching black part in the electrified surrounding (as shown in the following picture).

And, Each LCD manufacturer has a specified inverter, such as

NEC：

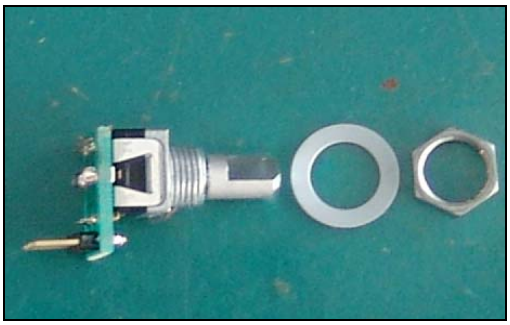


SHARP：



2.3.3.7 Knob assembly

Knob PCB: intend for connecting coder.



3 Testing

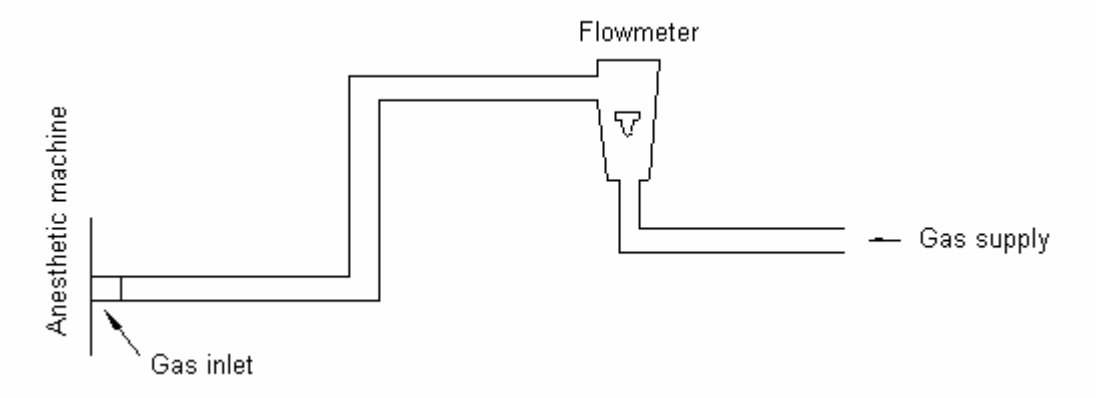
3.1 Pneumatic system test

3.1.1 Test pipeline leakage

Leak of the line from the inlet to flow valve:

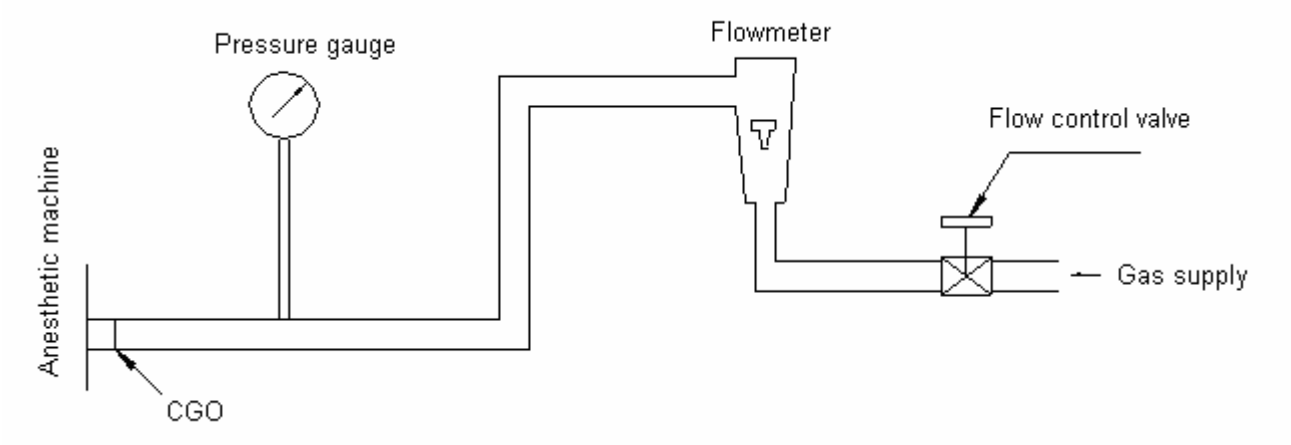
a. Turn off the flowmeter on the anesthetic machine. Ventilate the machine. And connect another flowmeter in series to air delivery pipe between air supply and anesthetic machine.

b. Adjust the pressure of air supply to normal working range (0.4～0.45MPa). Note the value of flow meter after the pressure became steady (refer to figure 1).The value should be less than 25mL/min.



Leak of the line from flowmeter to the collective gas outlet:

a. Turn off the first flowmeter on the anesthetic machine. Connect another flow meter in series to the outlet of the first flowmeter and the manometer to the collective gas outlet. (Refer to figure 2)



b. Turn off the second flowmeter. Then adjust the first flowmeter on the anesthetic machine to 100ml. slowly adjust the second flowmeter, making the value of manometer keep 3KPa. At this time, note the value of the second flowmeter.

c. Turn on and turn off the vaporizer respectively, and do the check above again. The value of flowmeter should less than 50mL/min.

3.1.2 Flowmeter linkage device

Turn off the controlling valve of oxygen. Then adjust the controlling valve of N2O slowly, making the flux show of N2O flowmeter become 1.5L/ min, 3 L/ min,6 L/ min, 9L/ min in turn. The corresponding flux show of oxygen should be no less than 0.5 L/ min ， 1 L/ min ， 2 L/ min ， 3 L/ min.

3.1.3 N2O cut-off device

Connect the O_2 and N2O (can replace by O_2). Open the controlling valve of O_2 and N2O on the flowmeter. Then gradually reduce the pressure of the oxygen supply. Observe the change of flux of O_2 and N2O. In the whole process, the ratio of flux O2 to N2O must be larger than 1:3. Namely, the flux of oxygen must be three times of the flux of N2O all the time. N2O would be cut off if the pressure of oxygen is in the range of 0.02MPa to 0.2MPa.

3.1.4 Oxygen lack alarm

a. Turn on the oxygen supply, making the pressure from 0Mpa to normal.

b. In the state of normal pressure of oxygen, ventilate the machine and last more than 30 seconds.

c. Cut off the oxygen supply.

In the process of turning on the oxygen supply, observe the value of O2 pressure gauge. The alarm should disappear before the value get to 0.23Mpa.

In the process of turning off the oxygen supply, observe the value of O2 pressure gauge. The alarm should happened when the value is in the range of 0.05MPa～0.22MPa, and the time of alarm longer than 7s.

3.1.5 Oxygen flush

Connect the flowmeter which range is 10L/min～100 L/min to the common gas outlet when the input pressure is 0.4～0.45MPa. Turn on the oxygen flush valve. And observe the indicated value which should be in the range of 35 L/min ～75 L/min.

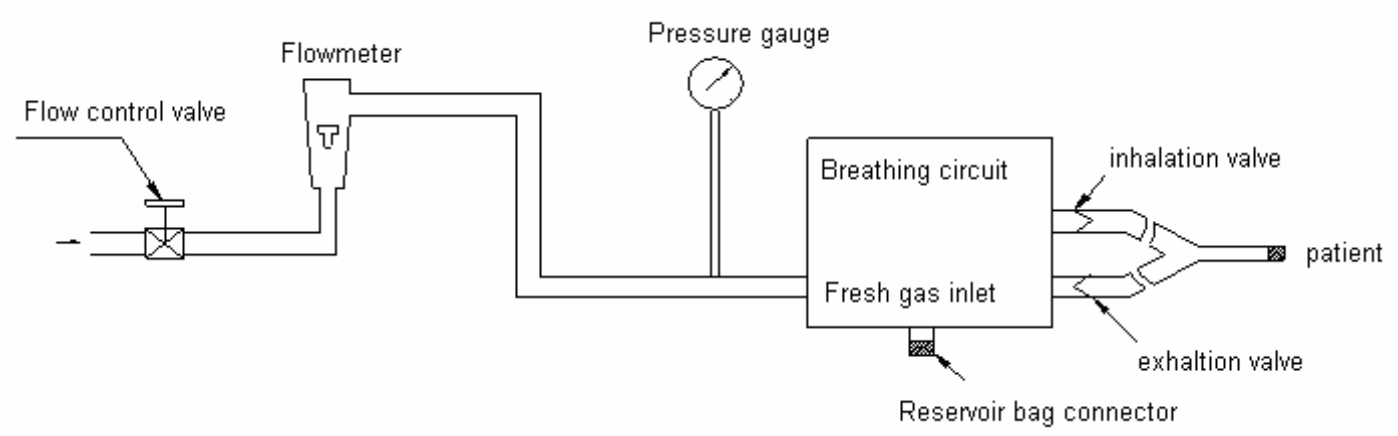
3.1.6 Test breathing circuit leakage

a) Stifled the joint which leads to air reservoir and the patient end of tee fitting.

b) Turn off the APL valve.

c) Insert a flowmeter in the circuit （See figure 3）.

d) Adjust the flow valve, making the valve of pressure gauge keep at 3KPa. The value of flowmeter should not larger than 120ml/min.



3.1.7 Vaporizer

1. Place the vaporizer into the testing room more than 3 hours (20±3℃). The vaporizer should be tested solely.

2. Pour the vaporizer until the value of anesthetic is beyond the lower limit with 10ml. test the vaporizer 45 minutes later.

3. Place the anesthetic gas analyzer to the exit of vaporizer to testing.

4. Adjust the flux of the vaporizer to 1 L/min and 5 L/min in turn. Observe the concentration show of the anesthetic gas analyzer after one minute.

5. When the vaporizer at the place of “OFF”，its output concentration should not larger than 0.1%.

6. The error of gauged concentration should no less than 20% or 5% of the full range.

3.2 Test MV300 anesthetic ventilator

3.2.1 Testing equipments

a) stopwatch；
b) ventilating meter；
c) digital pressure gauge or “U” manometer；
d) 3L- Reservoir Bag and fish joint haggis；
e) Oxygen cylinder, the concentration > 95%
f) digital multimeter；
g) oxygen monitor；

3.2.2 MV300 standard operation parameters

—— ventilation mode：VCV mode
—— tidal volume：600mL；
—— breath frequency：20times per minute；
—— I:E：1：2；
—— Lower limit of airway pressure：0.5kPa；
—— Upper limit of airway pressure：4kPa；
—— Tp: OFF

3.2.3 Debugging step

1. adjust the voltage

Switch on the power supply. Adjust the potentiometer W2 and measure the first feet voltage of U3 on the forward board using multimeter to make the output voltage is 8V±0.01V.

2. Calibrate O_2 sensor

Select the menu option of O2 sensor checking, check the 21% and 100% item in turn according with the cue in the menu, then unbolt the O2 sensor from the machine. At this point, we can see the montor value of O2 is '- -'.

3. Calibrate flow sensor

Select the menu option of flow sensor, and check the flow sensor according with the cue in the menu.

4. Calibrate flow valve

Install the ventilator onto the anesthesia, connect the pipeline, and use water lung as stimulant lung. Ventilate at the standard working state and set the tidal volume as 200ml, 600ml respectively. If the error of the output contrasted with the set point is more than +20% or -20% as each change of the set of tidal volume, please check the proportioning valve.

The process is: under the menu of the sensor, select the check of the proportioning valve. And change the water lunge with 3L bursa. Go into password "2020" then select OK to checking.

Note: At the process of checking, you can exit by pressing "menu".

5. Check the tidal volume

At the standard rating, fix the MV300 onto the anesthesia machine. connect the flow sensor and pipelines，and then set the tidal volume to 0ml, 200mL, 400mL, 600mL, 800mL, 1500mL in turn. Connect the 3L- bursa and the fish joint haggis with the patients respectively. (when use fish joint haggis, the max of tidal volume should be less than 600mL.) After the display on the screen become steady, measure the tidal volume using the ventilatory capacity meter. You should get a set of data as follow: 0±15mL, 200mL±20mL, 400mL±40mL, 600mL±60mL, 800mL±80mL, 1500mL±150mL; Compare the measured data with the monitor data by MV300， the error should in the range of ±10%. At the standard rating, we can adjust the respiratory rate to 10 BPM if the tidal volume can not reach 1500mL.

6. The display of minute volume

At the standard setting, set the tidal volume to 0ml, 200mL, 400mL, 600mL, 800mL, and 1200mL in turn. After the display on the screen become steady, measure the expiration tidal volume VTe using the ventilatory capacity meter. Observe the monitoring value of minute volume after one minute. Compare it with the calculated value of the expressions MV=VTe×T, the error should in the range of ±20%.

7. The display of total frequency

Set the respiratory rate to 4 BPM, 20BPM, 40BPM, 100BPM in turn. Compare the monitor data with the times of ventilating in one minute, if the rate is below 20BPM, the error should be in the range of ±2BPM, otherwise, ±10%.

8. I:E

At the standard rating，change the I:E from 1：0.5 to 1：8, we can see the respair time of ventilator changed clearly, namely, the time of inspiration is shortening gradually.

9. The display of pressure in air passage

Connect the manometer and pressure sampling outlet of ventilator to standard batching container. Pressurize the pressure sampling outlet by the standard batching container to make the manometer stabilize at 0kPa、1kPa、+2kPa、+4kPa、+6kPa. Note the undee data of airway pressure. If the pressure is in the range of 0kPa～+2kPa, the error should be ±200Pa, if the pressure is 2kPa～6kPa, the error be ±10%. You should check as the flow, if not meet the demand.

At the standard settings, put the pressure sampling outlet into the air, adjust the potentiometer W3 on the front board. At the same time, observe the pressure waveform on the screen. Firstly, adjust the peak value to above 2cmH_2O. Secondly, adjust the potentiometer W3 negative direction till the peak becomes 0. And then set the pressure upper limit of the ventilator to 60cmH_2O. Connect the pressure sampling and U model manometer to injector. Pressurize by injector to make the making the U model manometer show 60cmH_2O. At the same time, adjust the potentiometer W1 on the front board till the peak value become 60cmH_2O on the beam.

Set the time of hold breath to OFF, 5%, 25%,50%. When to OFF, there is not flat pressure, others the flat pressure is in existence. At the same time, you would find the time when the velocity of flow is zero is lengthening as the time of hold breath increased if you observe the waveform of flow.

10. Display of oxygen concentration

Connect the O2 sensor with ventilator. Firstly, place the O2 sensor and oxygen analyzer in the air. Secondly, note the display data of the ventilator and oxygen analyzer. Then place them into 100% pure oxygen. Note the data again after 3 minutes. The error should be in the range of ±5%.

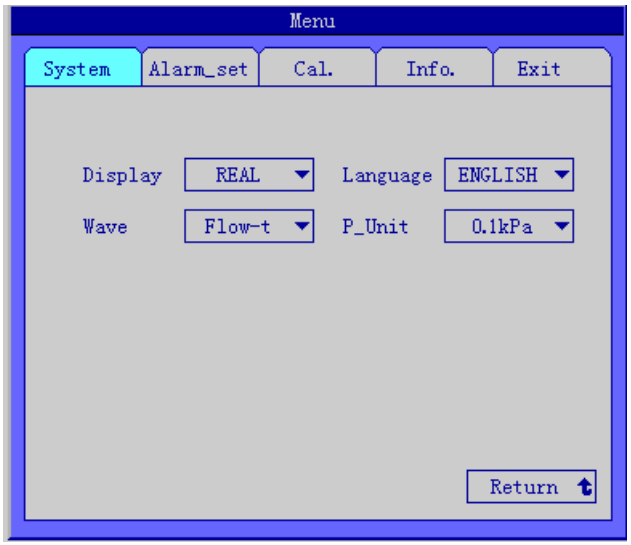
11. Monitor of the compliance C

At standrad rating, set the tidal volume to 0, 500 mL, 1000 mL in turn. Note the the volume of inspiration tidal volume, the peak value of pressure Ppeak, and the pressure when the expiration is end, Ppeep. Count the C by the expressions as follow. When the value of C is under 10 mL/hPa,the error is ±2 mL/hPa, or else, the error is ±20%.

C = Vt /ΔP……..(1)
In the expressions:
ΔP=Ppeak-PEEP, hPa;
Ppeak——the peak value of pressure, hPa;
PEEP——the pressure when the expiration is end, hPa;

12. System submenu

Press MENU key, the menu window pop-up on the screen, showing as follow.
Go into this menu, you can select the mode of display between demo and real time waveform. There is two choice of language: English and Chinese. Waveform includes Flow-t, Paw-t, V-t, CO_2-t, P-V ring. You can select the unit of pressure from 0.1kPa and cmH_2O.



13. Alarm setting

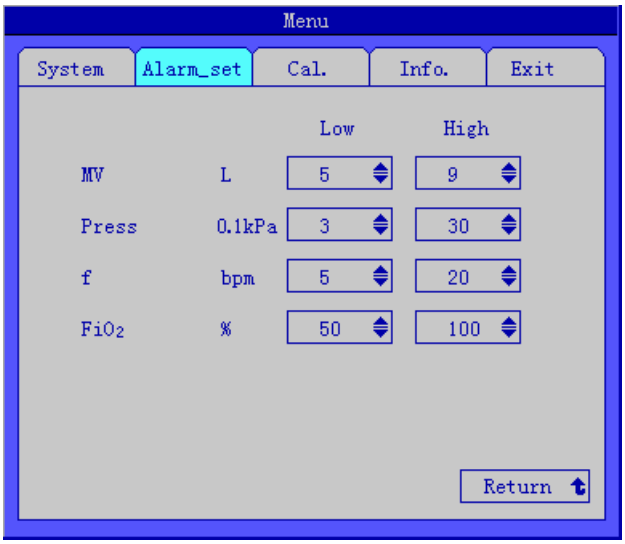


图 3

a) Alarm for exceeding the upper limit of per minute expiration volume

Set the upper limit value of per minute expiration to 1L, 5L, 10L, and 20L in turn. adjust the tidal volume，until the alarm for exceeding the upper limit of per minute expiration volume occurs. Note the data of per minute expiration volume inspecting by the breath inspecting machine. Compare it with the setting data. If the per minute expiration volume is below 5L, the error is in the range of ±1 L. If it is above 5L, the error is in the range of ±20%.

b) Alarm for exceeding the lower limit of per minute expiration volume

The method is same as the a).

c) Alarm for exceeding the upper limit pressure of air passage

Set the upper limit pressure of air passage to 2kPa、4kPa、8kPa in turn. Connect the manometer to the pressure sampling outlet. Then pressurize the sampling outlet with injector until the alarm of exceeding the upper limit pressure of air passage occurs. Note the volume of the manometer, the error should be in the range of ±8％.

d) Alarm for exceeding the lower limit of airway pressure

Set the lower limit pressure of air passage to 0, 0.5kPa, 1kPa, and 2kPa in turn. Pressurize the pressure sampling outlet with standard measuring container to make the pressure of air passage reach the setting of lower limit or a little short. Increase the pressure after the alarm occurs, till the alarm disappeared. Note the indicate value of pressure gauge, the error should be in the range of ±15%. At the same time, quickly adjust the pressure of the air passage to the setting of lower limit or a little short. Time with the stopwatch until the alarm occurs again. The time should be between 4s and 15s.

e) Alarm for exceeding the upper limit of respiratory rate

Set the data of upper limit of respiratory rate to 4bpm, 20 bpm, 100 bpm in turn. Adjust the parameters of respiratory rate until the alarm for exceeding the upper limit of respiratory rate happening. Note the count value of respiration rate. Compare it with the value of the setting. If the respiratory rate is less than 20 BPM, the error is in the range of ±1 BPM. Others ,the the range is ±5%

f) Alarm for exceeding the lower limit of respiratory rate

The method is same as e).

g) Alarm for exceeding the upper limit of oxygen concentration

Adjust three O_2 which concentrations are differ. Mix them enough. Connect the O_2 sensor with probe of the oxygen analyzer passing through the tee, and then put them in the air. Adjust the data of upper limit of respiratory rate until the alarm for exceeding the upper limit of respiratory rate happening.

h) Alarm for exceeding the lower limit of oxygen concentration

The method is same as g).

17. Ventilation Mode

a) Standby Mode

At the state of Standby Mode, all parameters are effective.

b) VCV mode

At the state of VCV Mode, the parameter of Plimit is ineffective, displaying‘- -’. Set the breathing rate to 20 BPM. The respiratory rate should be 19～21 BPM.

c) Pressure Mode

At the state of Pressure Mode, the parameter of Tp is ineffective, displaying‘- -’. Set the parameter of Plimit, ventilate the machine, and then note the peak value of pressure. Compare the value with the setting Plimit. If airway pressure can go up to the setting Plimit, the peak value should not exceed the setting Plimit at 2cmH_2O. At the same time, the machine stops ventilating and turn to expiration after the inspiration was closed. If airway pressure can not go up to the setting Plimit, the error between output tidal volume and setting tidal volume should be in the stated range.

d) Manual Mode

At the state of Manual Mode, only the alarm parameter is effective. The invalidation shows ‘- -’. Turn the Manual/Machine switch to Manual Mode. Press the bursa according to a stated rate. At the same time the times of extrusion in one minute. Compare it with the monitor data of breathing frequency, the error should be less than 2 BPM. Compared the monitor data of tidal volume with the measured value of air flow meter, the error should be in the range of (±10%).

e) SIMV Mode

At the state of SIMV, the parameter of Tp and Plimit are noneffective showing ‘- -’, the area of “f” display $f_{IMV.}$ I:E display the time of inspiration（T_I） with the unit of second. Vsens be come effective with the unit of L/min. If we set the f_{IMV} to 4 BPM, Vsens to 3 L/min, pressed the bursa, the ventilator can also touch off and ventilate.

18. Operating key

The key on the faceplate of the ventilator should accord with its function.
When an alarm accruing, press the key of Silence, the alarm should be muted. At the same time, there is a figure which is degressioning from 110s in the area of alarm condition indication.
The key of Manual can switch come-and-go between Manual Mode and other Modes.

19. Safe working pressure of air passage

At the standard state, set the pressure upper limit of the ventilator to 80cmH_2O, plug up the patient end, and then note the pressure of the air passage when the safety valve deflating. This pressure should be in the range of 5kPa ~6kPa. You should adjust the safety valve of air passage if it can not satisfy the require.

4 Troubleshooting

4.1 Anesthesia machine troubleshooting and analyzing

Symptom	Possible Cause	Recommended Action
Patient breathing circuit gas leak	APL valve is on	Turn APL valve to off
	soda lime in the cylinder port is not sealed very well	Reinstall or remove the natrium calcareousness grains at the joint
	Screw tubes are broken or the connector loosens	Replace or reinstall
	valves loosen	Tighten them
	Bag / ventilator switch failure	Please contact eligible service representative.
Excessive pressure caused by manual ventilation	APL valve is adjusted incorrectly	Adjust it properly
Switch to bag control, bellows charging; switch to ventilator control, bag charging.	Leakage occurs at bag / ventilator switch.	Please contact eligible service representative.
APL valve doesn't work normally	APL valve failure	Please contact eligible service representative.

4.2 MV300 Troubleshooting and Analyzing

Malfunction	Causes	Solution
Press POWER key, the screen is not bright.	Short occurs.	Contact our company.
	For early machines, capacitance may be not matched.	Suggest updating.
Press POWER key, not only the screen and the keyboard's lights do not work, also high frequency sharp voice occurs at the same time.	The circuit is abnormally.	Shut off power immediately, and call professional to deal with it. Warning: Do not attempt startup it again, forbidden continuing to supply current.
Press POWER key, no abnormal phenomenon else, but screen and keyboard's light don't work.	The circuit cut off, perhaps the power-line of sensor-board disconnected.	Reconnect it rightly.
Press POWER key, no any reaction occurs, and indicator of switch power supply is not bright.	Connection with power supply failed. When to use battery, the capacity of battery may be not enough, or connection failed.	Make sure the power supply working normally. Charge the battery or reconnect it rightly.
	Switch power supply damaged, or connection failed.	Replace the new one, or reconnect it rightly.
Press POWER key, no any reaction occurs, and indicator of switch power supply is bright.	1. Pressing time too short. 2. 9-pin line is not connected. 3. Circuit failure.	Increase pressing time. Connect 9-pin line correctly. Turn to professionals.
Any operation for knob and keys is invalid.	Program chip failure.	Turn off the apparatus, contact our company.
Any operation for keys is invalid, only the knob can be responded, But rotating function failure, push the knob, the tidal volume increased.	Connection of keyboard is wrong.	Reconnect according to this manual.
SIMV mode can't be found.	Optional function.	---
The bellows doesn't work.	Flow valve controller lines disconnected. Flow valve calibration failure.	Connect the lines. Recalibrate flow valve. Caution: It takes longer time in the calibrating process.

The monitoring data of tidal volume is inaccurate.	Differential pressure sensor failure.	Change with new one.
	Flow valve calibration failure. Breathing circuit leakage or seeper.	Use software to calibrate flow valve. Replace flow valve. Carry out maintenance. Turn to experts.
Restart frequently.	Circuit-board can not match The circuit damaged	Keep out the spot, not testing oneself, turn to experts
There are black-line or color-line on the screen	LCD failure. The data-line and data-line interface are not connected with LCD correctly.	Replace LCD. Change data-line and reconnect, if failed again, check the connectors. Turn to experts.
LCD brightness is very dim.	LCD harness damaged or disconnect.	Reconnection.
The tidal volume monitoring value is zero, but connection is right and bellows works normally.	The gas pressure valve failure. Sensor-board failure.	Replace sensor-board.
No pressure-time waveform	Sampling tube fell off Flow probe fell off Flow probe blocked.	Reinstall sampling tube Reinstall flow probe Cleaning or change the sampling probe
Tidal volume is inaccurate.	Perhaps sampling tube pond, leakage, sampling probe damaged. Flow sensor calibration failed. Flow valve calibration failed.	Check up the part carefully, replace it necessarily. Recalibrate it.
Manual ventilation turn to mechanical ventilation is slowly.	It needs 5 minutes to operate before operation. Flow valve calibration failed.	Keep the machine operate usually Recalibrate it.
Small tidal volume is inaccurate.	Beyond the allowable range probably. Perhaps ventilation mode used is not correct Flow sensor calibration may be abnormal.	100mL is reachable, but 50mL is not recommended. Turn to pressure mode Ensure that flow sensor calibration can be performed correctly.
When ventilator working, bellows does not work, Exhaust port blowing	Exhalant block failure. The connection of data line is failure. The magnetic valve of exhalant block is failure.	Check the exhalant block carefully. Reconnect it rightly. Check or change.

The pressure of ventilator is on the high side.	The alarm setting is not correct. Sampling tube blocked.	Reset the alarm limits. Check or change.
No power provide to ventilator.	Perhaps the power line disconnects. Perhaps the power switch does not turn on. Power key on the screen is not pressed for 3 seconds Date line disconnects.	Check and reconnect it. Turn the power switch on. Press power key lasting for 3 secs. Reconnection
The knob can't be operated, and the cursor on the screen either.	Date line disconnects.	Reconnection. Startup again, if the malfunction exists, Check the knob PCB and connection. Turn to experts.
No patient parameters display.	Sampling probe falls off Sampling tube falls off, connection is wrong. Date line disconnects.	Reset probe rightly. Reset tube and connect it again. Reconnection.
There's a great difference between inhale tidal volume and exhale tidal volume.	Sampling probe and tube seeper. Check the flow sensor. The sampling tube leaks.	Eliminate the seeper. Calibrate flow sensor. Reconnect it rightly.
The ventilator works for some time, and then power off.	Mains supply is not steady. Battery capacity is not enough.	If the undulation of mains supply is very strong, recommend to use manostat. Check and charge.
Flow sensor calibration failed.	Affected by temperature drift.	Avoid seeper, and calibrate it after operating 20 minutes.

5 Specifications

5.1 System technical specification

5.1.1 Drive

Gas supply:

Pipeline:	O_2, Air, N_2O
Cylinder:	O_2, N_2O
Connect to cylinder:	PISS (pin-indexed safety system)
Reducer:	400kPa
Connect to pipeline:	DISS-male, DISS-female, NIST (ISO 5359) All fittings used to connect O_2, Air and N_2O pipeline gas supply are all ready.
Display pressure:	Gauges with color coded
Input pressure at pipeline inlets	0.4MPa

⚠ **WARNING: All gas supplies must be in accordance with medical level.**

⚠ **CAUTION: Pressure at pipeline inlets must be according to 280 to 600kPa when delivering ceases in the anesthetic gas delivering system.**

5.1.2 Flow

Gas component	Scale (thin tube)	Scale (thick tube)
O_2	0.05 to 1 L/min	1.1 to 10 L/min
N_2O	0.05 to 1 L/min	1.1 to 10 L/min
Air	----	0.1 to 10 L/min

Accuracy: With regard to the flow between ±10% of full scale or 300 ml/min (higher is preferred) and full scale under the condition of 20C, 101.3kPa, flow meter precision is within the ±10% of indicated values. The precision is 4 degree when the flow is lower than 10% of full scale or 300 ml/min (higher is preferred).

Adjust O_2 and Nitrous oxide proportionally to ensure the O_2 concentration is no less than 25%.

O_2 flush: 35 to 75 L/min

O_2 failure alarm and the associate cut-off device

	O_2 pressure
O_2 failure alarm:	50 to 220kPa
N_2O cut-off:	20 to 200kPa

⚠ **CAUTION:** **O_2 failure alarm takes precedence of N_2O cut-off.**

5.1.3 Classification

According to IEC60601-1, Anesthesia 7500A belongs to the following classifications:

- Class I equipment
- Type B equipment
- General equipment
- Mobile equipment
- Flammable anesthetic cannot be used
- Operate continuously

5.2 Power supply

Voltage:	230VAC 50Hz
Input power:	Not more than 50VA
Maximum input current:	5.5A
Fuse at mains supply inlet:	250V 6A Φ5X20 (F)
Fuse above auxiliary mains socket outlets outlet:	250V 2A Φ5X20 (F)
Maximum output current of auxiliary mains socket outlets:	1.5A (each); 4.5A (total)
Fuse in rear of ventilator:	250V 1A Φ5X20 (T)
Earth resistance:	<0.2Ω

⚠ **WARNING:** **Then connection of equipment to the auxiliary mains socket outlets can increase the patient leakage currents to values exceeding the allowable limits in the event of a defective protective earth conductor.**

5.2.1 Power cord

Length:	5 meters
Rating voltage:	90 to 264VAC
Capacity of current:	220 to 240VAC 10A
Type:	Three-core cable (Medical level)

5.3 Electromagnetic Compatibility

Changing or reassembling this equipment without authorization may cause electromagnetic compatibility problems. Contact with our company for assistance. Designing and testing this equipment is in accordance with the following stipulations.

⚠ **WARNING:** **using cell phone or other radio radiant equipment near this product may cause malfunction. Closely monitor the working condition of this equipment if there is any radio radiant supply nearby.**

Using other electrical equipment in this system or nearby may cause interference. Check if the equipment works normally in these conditions before using on a patient.

Be careful of the following when Anesthesia 7500A is connected:

Do not put any object which is not in accordance with EN60601-1 in the 1.5M range of patients.

An isolated transformer must be used for alternating current supply (in accordance with IEC60989), or additional protective ground wires are equipped if all the devices (for medical or non-medical use) are connected to Anesthesia 7500A by using signal input/signal output cable.

If a portable all-purpose outlet is used as the alternating current supply, it must be in accordance with EN60601-1-1 and cannot be put on the floor. Using another portable all-purpose outlet is not recommended.

Do not connect the non-medical equipment directly to the alternating current outlet on the wall. Only the alternating current supply of the isolated transformer can be used. Otherwise, the surface leaking current may exceed the range permitted by EN60601-1 under the normal conditions, and misoperation may cause injury to patients or operators.

Anesthesia 7500A is equipped with all-purpose alternating current outlet for connecting other medical equipments. Do not connect non-medical equipment to these outlets. Otherwise, the surface leaking current may exceed the range permitted by EN60601-1 under normal conditions and misoperation may be dangerous to patients or operators.

A complete system current leaking test (according to EN60601-1) must be performed after any equipment is connected to these outlets.

⚠ **WARNING:** **medical electrical equipment operators contact non-medical electrical equipment and patients at same time. It is dangerous of patients or operators.**

5.4 Physical specification

All specifications are approximately, maybe changed at any moment without notice.

⚠ **CAUTION: Do not put Aeon7500A into the shock environment.**

⚠ **CAUTION: Do not lay the heavy on the top or into the draws.**

System	Height	1350mm
	Width:	656mm
	Depth:	622mm
	Weight:	148kg
Castor	125mm (5 in.), with breakers on the front castors.	
Drawer	130mm (H) ×465mm (W) ×360mm (D)	
Display	10.4’ TFT LCD	
Cylinder gauge	Scale: 0 to 25MPa. Resolution: 50kPa. Accuracy: ±2.5% of full scale.	
Pipeline gauge	Scale: 0 to 1MPa. Resolution: 1MPa. Accuracy: ±2.5% of full scale.	
Airway gauge	Scale: -2 to 10kPa. Resolution: 200Pa. Accuracy: ±2.5% of full scale.	

5.5 Environment requirements

Temperature	Operation:	10 to 40 ℃
	Storage:	-10 to 40 ℃
Relative Humidity	Operation:	Not more than 80%, non-condensing
	Storage:	Not more than 90%, non-condensing
Atmospheric pressure	Operation:	86 to 106kPa
	Storage:	86 to 106kPa
Height	Operation:	500 to 800 mmHg （3565 to -440m）
	Storage:	375 to 800 mmHg （5860 to -440m）

5.6 Breathing system technical specifications

Compensation of fresh gas	Flow compensation range: 0 to 10 L/min Gas components: O_2, N_2O, air, anesthetic agent
Absorbent	Capacity: 1500 ml (each)
Connection	Common Gas Outlet: ISO 5356 connector
Leakage of breathing system	At pressure of 3 kPa: Leakage of flow: ≤150 ml/min
Resistance of breathing system	At flow of 60L/min: Resistance of exhalation: ≤0.6 kPa; Resistance of inhalation: ≤0.6 kPa. At flow of 30L/min: Resistance of exhalation: 2.2 kPa; Resistance of inhalation: 2.2 kPa. Patient cycle of small resistance should be used in accordance with the relevant standard.
Resistance of APL valve	At flow of 60L/min, resistance of flow: 0.05 to 3 kPa; At flow of 30L/min, resistance of flow: 0.1 to 0.5 kPa.
Leakage of connector	Resistance of flow: ≤50 ml/min. (APL valve close fully)
Resistance of checkvalve	Dryness: ≤0.15 kPa

The pressure generated by a wet unidirectional valve: <0.14 kPa;
The pressure to open a wet unidirectional valve: <0.1 kPa

Compliance of absorber	<50 ml/ kPa

5.7 Anesthetic ventilator

5.7.1 Performance of ventilator

Maximum security pressure of airway system	Not more than 6kPa
Compliance:	Not more than 40mL/kPa
Electrical safety:	Meet requirements for Class I, type B equipment specified in EN60601-1 *Medical Electrical equipment: Part one: General requirement for safety*.
Noise of whole unit:	Not more than 65dB(A)

5.7.2 Setting ventilation mode

Ventilation mode	Adjustable respiratory parameters
VCV mode	V_T、f、I：E、T_P（inspiratory pause）
Pressure mode	V_T、f、I：E、Plimit（maximum airway pressure limit setting）
SIMV mode	V_T、f_{IMV}、T_I、Vsens（trigger sensitivity of volume）
Manual mode	----

5.7.3 Setting ventilating parameters

	Range	Resolution
V_T:	0, 50 to 1500mL	10mL
	Maximum V_T output limited by 75L/min (see 10.8.5 flow valve)	
f:	4 to 100bpm	1bpm
I：E:	1:0.5 to 1:8	0.5
T_P:	5% to 50%, OFF (only available in VCV mode);	5%
P_{limit}:	0.5 to 7kPa (only available in Pressure mode);	0.1kPa
V_{sens}:	1 to 30 L/min (only available in SIMV mode);	1 L/min

5.7.4 Gas dynamics performance

Gas source:	Anesthetic system
Gas component:	O_2
Rating pressure:	250kPa
Input pressure range:	280 to 600kPa
Flow valve range:	5 to 75 L/min
Output:	Pressure range: 0 to 6kPa; flow range: 0 to 75 L/min

5.7.5 Setting alarm parameters

Item	Limit	Range	Resolution
MV (minute volume)	Lower	0 to 20L/min	1L/min
	Upper	1 to 25L/min	1L/min
Paw (airway pressure)	Lower	0 to 2kPa	0.1kPa
	Upper	2 to 8kPa	0.1kPa
f (respiratory frequency)	Lower	0 to 100bpm	1bpm
	Upper	4 to 110bpm	1bpm
FiO_2 (Oxygen concentration)	Lower	OFF, 21% ~ 100%	1%
	Upper	21% ~ 100%, OFF	1%

⚠ **CAUTION:** **If the alarm limits of FiO_2 are OFF, and O_2 sensor not connected, the "No O_2 sensor!" alarm will cancel.**

⚠ **CAUTION:** **All lower limits of parameters in above table may not be set up the upper limits, nor may the upper limits be set below the lower limits.**

5.7.6 Volume

Type of volume sensor	Pressure difference
Physiological dead space of sampling probe	9.5mL

5.7.7 Monitoring performance

Item	Range	Resolution	Accuracy
V_T:	0 to 2000mL	1mL	±30mL (below 200mL); ±15% (other)
MV:	0 to 30L/min	1L/min	±15%
f:	0 to 100bpm	1bpm	±5% (above 20bpm); ±1bpm (other)
P_{peak}:	0 to 8kPa	0.1kPa	±200 Pa (below 2kPa); ±10% (other)
P_{plat}:	0 to 8kPa	0.1kPa	±200 Pa (below 2kPa); ±10% (other)
FiO_2:	14 to 105%	1%	±3%
C:	0 to 99 mL/cmH_2O	1 mL/cmH_2O	±2 mL/cmH_2O (below 10 mL/cmH_2O) ±20% (other)

Electric quantity: 100%, 75%, 50%, 25%, 0%. If 0% displays, and mains supply not connected, the system will shut down.

Paw-t waveform: Pressure monitoring range:-20 to 80 cmH_2O。Paw-t waveform display pressure axis varies with the upper alarm limit of Paw:

0 to 30 cmH_2O	-10 to 40 cmH_2O
31 to 50 cmH_2O	-15 to 60 cmH_2O
51 to 80 cmH_2O	-20 to 80 cmH_2O

Paw-t waveform display time axis varies with the f setting:

0 to 20bpm	0 to 15 sec.
21 to 40bpm	0 to 10 sec.
41 to 100bpm	0 to 5 sec.

Flow-t waveform: Flow scale: -90 to 90L/min. Time scale: 0 to 15s.

V-t waveform: Y-Axis: Tidal volume, range: 0 to 1.2L.

Paw-V loop: Y-Axis: pressure; X-Axis: tidal volume.

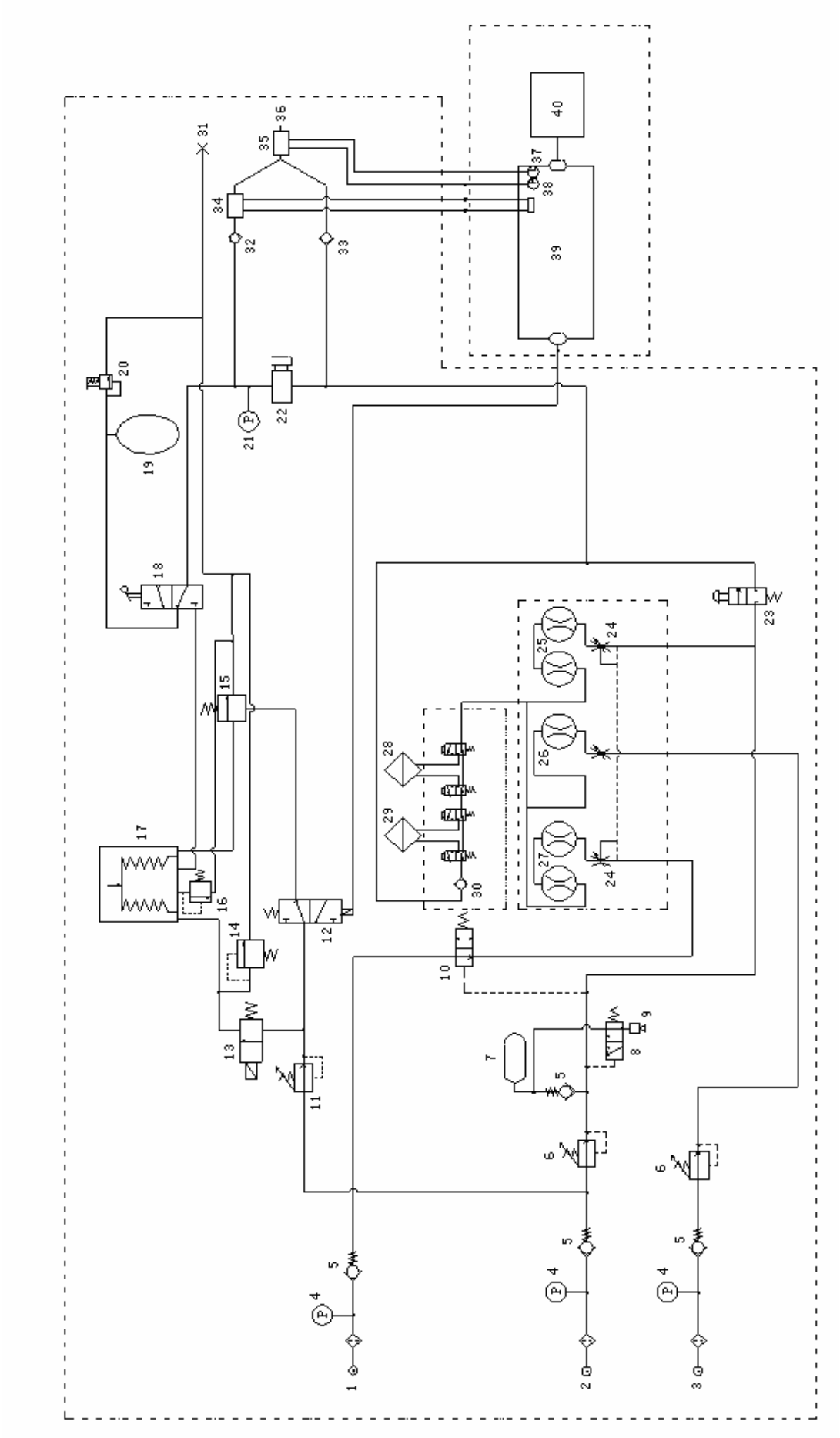
V-FLOW loop: Y-Axis: flow; X-Axis: tidal volume.

5.7.8 O_2 monitoring specification

Response time:	Not more than 15 seconds
Type of O_2 sensor:	Chemical fuel cell
Useful life:	12 months (normal operating)
Operational principle:	O_2 monitoring modules can monitor and display oxygen concentration of the patient circuit, and contain one oxygen sensor. The O_2 sensor can detect the proportionable voltage on its surface, generated with partial pressure of O_2. The O_2 sensor is chemical fuel cell, and its metal electrode can be oxidated when oxygen diffuses into it. The current generated from oxidation proportion O_2 partial pressure on the surface of electrode. The electrode will be used up gradually in oxidation process. The voltage of sensor would be affected by the temperature of gas mixture monitored. Thermistor on the shell of sensor will auto-compensate temperature difference inside the sensor. Signal processing and circuit analyzing can be used in the O_2 monitoring modules. So the signal of O_2 sensor could be transformed to O_2 concentration. Besides, the concentration displays on the screen, and compares with alarm limit value saved, if the concentration exceeds the limits, alarm should be occurred.

6 Schematics

1. N_2O pipeline
2. O_2 pipeline
3. Air pipeline
4. Pressure Gauge
5. Checkvalve
6. Reducer (400kPa)
7. O_2 reservoir
8. Reversal valve (100 to 220kPa)
9. Whistle
10. N_2O cut-off (20 to 200kPa)
11. Reducer (250kPa)
12. Magnetic valve
13. Flow valve
14. Safety valve (6kPa)
15. Exhaust valve
16. Spill-over valve (0.1 to 0.3kPa)
17. Bellows
18. Manual reversal valve
19. Manual reservoir bag
20. APL valve (0.19 to 0.6kPa)
21. Airway pressure gauge
22. Absorber
23. O_2 flush
24. N_2O-O_2 linkage
25. O_2 flowmeter
26. Air flowmeter
27. N_2O flowmeter
28. Vaporizer 1
29. Vaporizer 2
30. Micro-checkvalve
31. To air
32. Exhalation valve
33. Inhalation valve
34. O_2 sensor
35. Probe
36. Patient
37. Flow sensor
38. Pressure sensor
39. Ventilator
40. Display screen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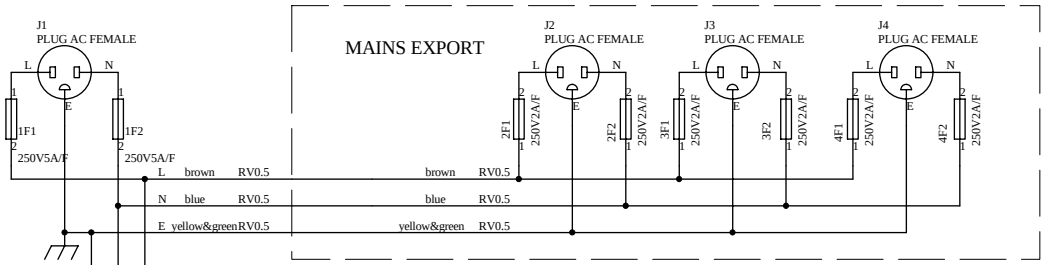

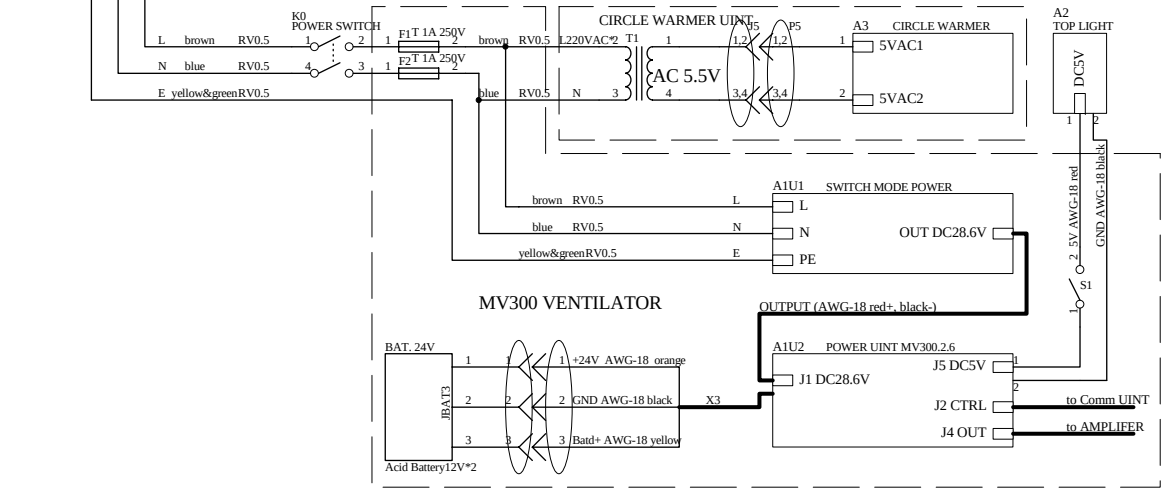

mark	wire color
J1	L N E
J2	E L N
J3	E L N
J4	E L N
J5	1,2 3,4
P5	1,2 3,4
F1	1 2
F2	1 2
1F1	1 2
1F2	1 2
2F1	1 2
2F2	1 2
3F1	1 2
3F2	1 2
4F1	1 2
4F2	1 2
K0	1 2 3 4
S1	1 2
A1U1	E L N
A1U2-J5	1 2
A2	1 2
A3	1 2
T1	1 4 2 5
A1U2-J1	1 2 5
JBAT3	1 2 3
RV0.5	brown blue brown brown blue blue yellow&green brown blue brown blue brown blue yellow yellow yellow yellow brown blue brown blue
AWG-18	red black red yellow green black

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MAIN WIRING

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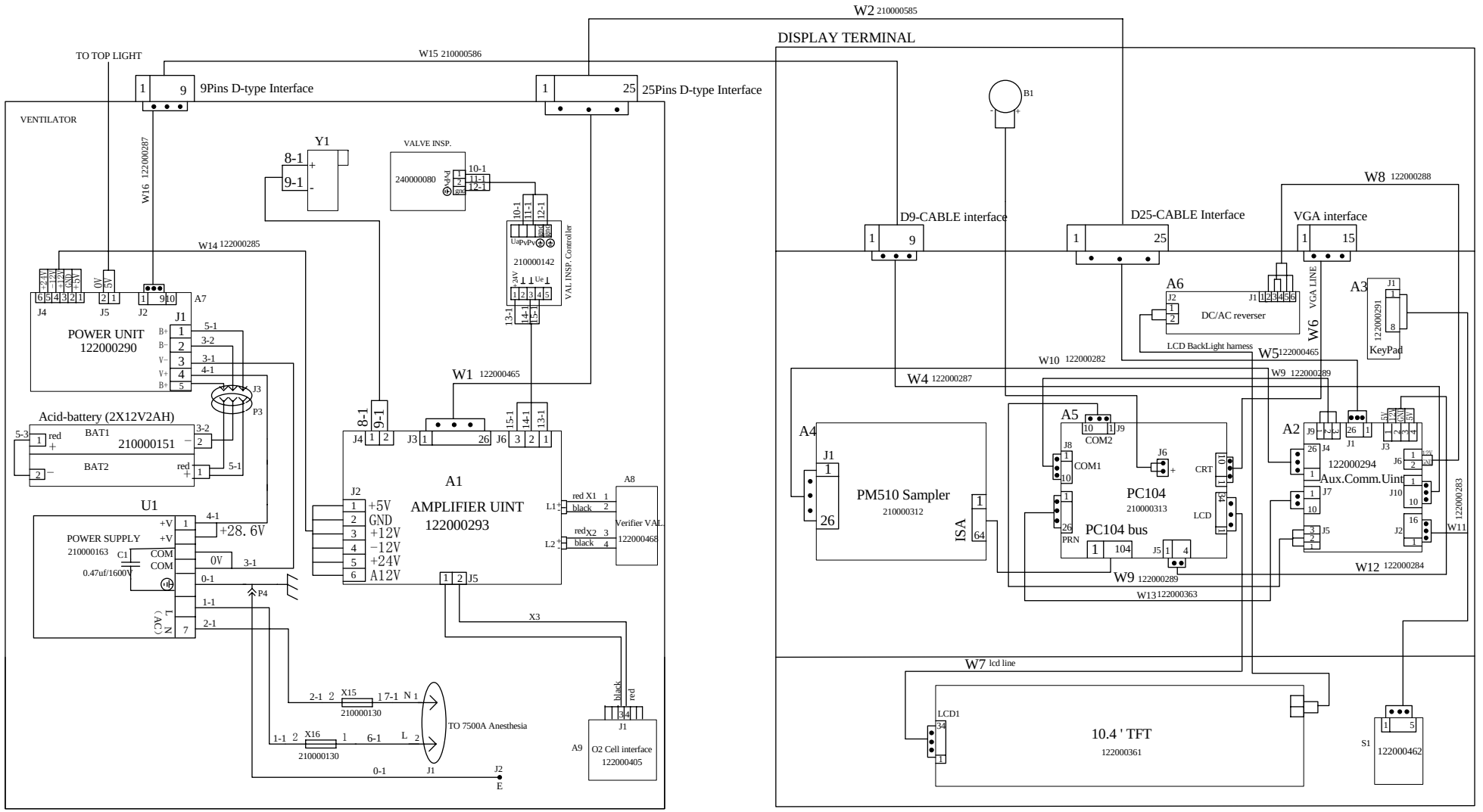

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